THURSDAY, DECEMBER 20, 1900.

A MODERN SCIENTIFIC INDUSTRY.

Jena Glass and its Applications to Science and Art. By Dr. H. Hovestadt. Pp. xii + 429. (Jena: Fischer, 1900.)

THIS is a volume of some four hundred pages, in which Dr. Hovestadt has collected a mass of information about the Jena glass.

In a report on the scientific apparatus of the London Exhibition of 1876, Abbe called attention to the need for progress in the art of glass making if the microscope were to advance, and to the necessity for obtaining glasses having a different relation between dispersion and mean refractive index than that found in the material then at the disposal of opticians.

He referred to the attempts made in England by Harcourt and Stokes with this object, and to the causes of their failure.

The task thus indicated was undertaken in 1881 by Abbe himself and Schott at Jena. The first catalogue of the Jena Laboratory, published in 1886, contains these words: "The industrial undertaking which is here announced for the first time arose out of a scientific investigation into the connection between the optical properties of amorphous fluxes and their chemical constitution."

The experimental work was only rendered possible by repeated and large subventions from the State. The immediate consequence of the undertaking was that by 1888 nearly all the glass required for optical work in Germany was of home manufacture; in a few years more an export trade in the raw glass began, the value of which in 1898 was over 30,000*l.*, while the value of the optical instruments, such as telescopes, spectacles, field glasses and the like, exported in the same year was nearly 250,000*l.* The trade at present employs some 5000 workmen.

When Abbe and Schott began their work, some six elements only entered into the composition of glasses. By 1888 it had been found possible to combine with these six quantities, up to at least 10 per cent., of twenty-eight additional elements, and the effect of each of these on the refractive index and dispersion had been determined.

Thus, for example, these investigators had found that by the addition of boron the ratio of the length of the blue end of the spectrum to that of the red is reduced; while fluorine, potassium and sodium produce opposite results.

Now an ordinary achromatic lens, uniting two colours of the spectrum, is formed by combining a crown glass lens with one of flint glass having equal total dispersion; but though the total dispersion is the same for the two it is differently distributed throughout the spectrum. In the flint glass the dispersion of the blue end is greater, that of the red less, than in the crown; hence the light from a white source is not white after traversing the lens; a "secondary" spectrum remains, and it was the existence of this which rendered the progress of the microscope so difficult. Abbe's experiments showed how the difficulty was to be met. By combining a high proportion of boron with flint glass, its spectrum became more nearly the same as that of a crown glass. Such a glass had been made by Harcourt many years previously, while a glass containing phosphates instead of silicates is found to have the same dispersion as, combined with a higher refractive index than, the ordinary crown glasses, and therefore serves better to achromatise the borate-flint glass. In fact, Abbe showed that with two such glasses it is possible to combine three colours instead of only two; the outstanding spectrum is greatly reduced in length, and is called a "tertiary" instead of a "secondary" spectrum.

Again, the ordinary microscope lens of two glasses can be corrected for axial spherical aberration for one colour only. Abbe showed that the new borate-phosphate lenses could, by combination with a lens of fluor-spar, have their axial spherical aberration corrected for two colours. These lenses he called apochromatic.

It was found more difficult to reduce the secondary spectrum by lengthening the red end of the spectrum of the crown glass. This required the addition, as we have said, of fluorine, potassium or sodium. The effect of sodium is small; glasses with a large amount of potassium can be made, but are very hygroscopic, while the introduction of fluorine though it was successfully effected, is involved with many difficulties.

The book under review gives, in its first two chapters, an account of the preliminary work of Abbe and Schott, and full details as to the optical properties of the glasses now made. The next four chapters deal with the optical instruments manufactured out of the glasses.

We have already referred to the fundamental improvement in the microscope rendered possible by their use; the problem to be solved in the case of a photograph lens was somewhat different. It follows, from the work of von Seidel, that, with the ordinary crown and flint glasses, the conditions for achromatism and for flatness of field cannot be satisfied together. To do this it is necessary to find a glass of high refractive index and low dispersive power, or *vice versâ*. In ordinary glasses refractive index and dispersive power go together.

Thus, ordinary hard crown glass has a refractive index of 1·518 and a dispersive power of ·0166, while for extra dense flint the figures are 1·717 and ·0339. An achromatic lens might be constructed out of these two glasses, but the field could not be flat.

By introducing barium, however, into the crown glass, a change is produced in this respect. Thus for barium silicate crown the refractive index and dispersive power are 1·573 and ·0173, while for soft crown they are 1·515 and ·0177. With these two glasses, the problem of constructing a photographic object-glass possessing achromatism and flatness of field becomes possible. For the various methods of solution we must refer to the book[1] itself, in which also will be found details as to the use of the glasses for telescopic lenses.

The mechanical properties of glass are next considered, and in Chapter ix. we come to a careful discussion of the imperfect elasticity of glass, specially in connection with thermometry.

[1] See also "Contributions to Photographic Optics," by Dr. Otto Lummer, translated by Prof. S. P. Thompson.

"About twenty years ago" (the quotation is from the catalogue of the German Instrument Exhibition at Paris) "the manufacture of thermometers had come to a dead stop in Germany, thermometers being then invested with a defect, the liability to periodic changes, which seriously endangered German manufacture. Comprehensive investigations were then carried on by the Normal Aichungs-Kommission, the Imperial Physical and Technical Institute, and the Jena Glass Works, and much labour brought the desired reward."

Dr. Hovestadt's account of the labour is most interesting and instructive.

The ice point of a newly made mercury thermometer is known to rise as the thermometer gets older; this rate of rise decreases with the time, finally becoming very slow. If, however, the thermometer be heated to, say, 100° C., and its ice point be taken very shortly afterwards, the reading will be below that observed prior to the observation of the steam point. This depression of the zero varies in amount in different thermometers. It was found (Weber in 1883 and Wiebe 1885–1886) to be specially large in the case of thermometers made of Thuringian glass, amounting in the case of one thermometer examined to 0°·65. As a consequence, the readings of the thermometers were quite uncertain, depending greatly on the past history of the instrument employed. It was this defect which Schott and Abbe set out to cure. Weber had observed that glasses which contained a mixture of potash and soda gave a very large depression. He succeeded in 1883 in making a glass entirely free from soda, in which the depression was only about 0°·1. The work was then taken up by the Aichungs Commission and the Jena factory. A number of thermometers of varying age and manufacture were examined as to the depression, and the glass of these thermometers was then analysed. Weber's conclusions were abundantly verified. An old thermometer of Humboldt's, containing 0·86 per cent. of Na_2O and 20·09 per cent. of K_2O, had a depression of 0°·06; a new instrument, in which the percentages of the two substances respectively were 12·72 and 10·57, had a depression of 0°·65. It is possible that this last thermometer was too new to give quite trustworthy results, but the difference is very marked. An English standard thermometer, with 1·54 per cent. of Na_2O and 12·26 per cent. of K_2O, had a depression of 0°·15, while a French "verre dur" thermometer, with 12·02 of Na_2O and 0·56 of K_2O, showed a depression of only 0°·008.

The next step was to manufacture a German glass with a low depression. The now well-known normal thermometer glass distinguished by the mark 16''' was the outcome of the experiments. This is a pure soda glass having the following composition :—

SiO_2, 67·5%; Na_2O, 14%; CaO, 7%; Al_2O_3, 2·5%; ZnO, 7%; B_2O_3, 2%,

and the depression observed is 0°·05.

The hydrogen thermometer is, however, the ultimate standard of appeal in thermometry, and it was necessary, therefore, to compare the new instruments with such a thermometer.

Details of the work are given in the book. It appeared, from the results of Wiebe and others, that at a temperature of 40° there was a difference of 0°·12 between the two nstruments. Experiments showed, however, that it was possible to produce a glass agreeing more closely with the gas thermometer than this, and this fact led to further work and to the manufacture of the boro-silicate glass 59''' with the following analysis :—

SiO_2 72%; Na_2O, 11%; Al_2O_3, 5%; B_2O_3, 12%.

This was found to show a smaller ice point depression, amounting, according to Hovestadt, to 0°·02, and to agree more closely over the range 0° to 100° with the hydrogen thermometer, the difference being greatest at 30°, where it amounts to 0°·038. For temperatures above 100° the differences are considerably greater than those given above, and the agreement between the scales is better for 16''' than for 59'''.

For details, however, of these comparisons, and of much more work of great interest as to the properties of these special glasses, reference must be had to the book. It constitutes a great record of what is to be achieved by the application of science, that is, "organised common sense" to an important industry. In England we have done nothing to compare with it. As a consequence, Germany can claim that "the manufacture of thermometers has reached in Germany an unprecedented level, and now governs the markets of the world." Such are the results obtained in twenty years by Abbe and his colleagues.

R. T. G.

ESSAYS BY DR. WALLACE.

Studies, Scientific and Social. By Alfred Russel Wallace. 2 vols. Illustrated. (London: Macmillan and Co., Ltd., 1900.) Price 18*s*.

IN addition to being one of the originators of the modern doctrine of animal evolution and one of the leading pioneers in the study of the geographical distribution of the earth's fauna, Dr. Russel Wallace is a writer noted for such a fascinating style and such a happy mode of presenting his views, that any work from his pen is sure of a hearty reception on the part of the more thoughtful section of the reading public. And even those who by no means agree with all his views—whether on scientific or social questions—cannot fail to admire the fairness with which he treats debatable points, and the temperate manner in which he replies to and discusses the objections raised by his critics.

The essays and articles collected in the two volumes before us embrace an extraordinarily wide range of subjects, and cover a period of no less than thirty-five years, the earliest of them being published as long ago as 1865, while the latest saw the light as recently as 1899. The variety of subjects discussed is alone a testimony to the wonderful mental capacity of their talented author, while the number of the periodical publications from which they have been culled bears evidence to the popularity of his writings. Those embraced in the first volume relate exclusively to various branches of geological and biological science, while those in the second are devoted to educational, political, sociological and kindred subjects. With the exception of a brief reference to two articles in the second volume dealing with museums as educational

establishments, our notice will be restricted to the section connected with natural science.

It may be as well to mention, before going further, that in a work dealing with such a variety of subjects as is the case with the one before us, it would be a practical impossibility to review it critically within any reasonable space; and we must accordingly content ourself with a brief survey of its principal contents.

Quite apart from the general interest of the book, as dealing with some of the most important biological and social topics of the day, there can be no question that, from the point of view of the working naturalist, the author has been well advised in publishing the essays of which it is composed in a collective form. Several of them are replies to criticisms on some of Dr. Wallace's views, while others, such as the one on the affinities and origin of the Australian and Polynesian races, contain entirely new views and theories. Before their publication in their present form it was, consequently, exceedingly difficult for a writer on any particular zoological subject to be sure that he had seen Dr. Wallace's last words on that subject. Indeed, the writer of this notice feels that he owes an apology in that, when writing an essay in favour of the Caucasian affinities of the Australians, he was unaware that Dr. Wallace had previously urged the same view. In one respect, the omission may perhaps be regarded as fortunate, as it permitted the same conclusion to be reached independently.

From the fact that some of the articles are more or less recent while others are of considerable antiquity, it will, of course, be evident that they have by no means all an equally important bearing on disputed questions of the day. The one on the evolution and distribution of animals, for example, dates from the early days of the study of that subject, whereas that on the distinction between the Palæarctic and Nearctic regions deals with a proposed amendment of the author's classification.

The first five essays deal mainly with the agencies that have modified certain parts of the surface of the globe, the alternations that have taken place in the distribution of sea and land, and the state of the interior of the globe. In the main, Dr. Wallace is a strict uniformitarian, and his account of how even the deepest and steepest mountain valleys have been eroded by the ordinary denuding agencies will be read with interest. He is fully convinced of the important part played by ice in the modelling of the earth's surface during the Pleistocene period, and pays no heed to the arguments that have been urged of late years against the former existence of an ice age. Whether his adherence to the theory of the erosive action of ice as the dominant factor in the formation of lake-basins will commend itself to many modern geologists may be doubtful; and the denial by some that such a thing as a true rock-basin exists would, if fully confirmed, to a great extent annul several of his arguments.

In the essay on the permanency of ocean-basins the author, in the main, pleads in favour of his original views, and offers some objections to the theory of large continental and ocean changes which demand respectful and serious attention on the part of those who differ from him in this respect. Nevertheless, in granting the possibility that such alternations of sea and land may have extended to such parts of the ocean as lie approximately within the limits of the two thousand fathom line, he has conceded much that is demanded by his opponents. Indeed this extension of the limits (formerly fixed at the 1000 fathom line) would practically admit of a land connection, at least by way of Antarctica, between South America and Africa, if not also between South America and Australia. And to learn how strong is the evidence in favour of such connections, the reader need only consult the paper recently read by Prof. Scott before the British Association.

Among the essays on descriptive zoology, attention may be confined to the one on monkeys and their affinities, which originally appeared (without the illustrations) in the *Contemporary Review* for 1881. It is an interesting and well written survey of the leading groups of these animals, in the course of which the author raises the question whether the Primates, other than man, are rightly regarded as the head of the animal kingdom. In this article, as in several others, we think it a pity that the author has not seen fit to adapt his nomenclature to that now current among systematic zoologists, and that he clings to such discarded names as Cynocephalus, Mycetes and Cuscus. Moreover, we notice on page 156 the misprint *babuino* for *babuin*; and we venture to affirm that the statement on the following page to the effect that the mandrill in size and strength is not much inferior to the gorilla is scarcely consonant with the facts—certainly not so far as size alone is concerned.

Of the articles on geographical distribution, two deal with North American flowers and trees and their differences from those of Europe, a third treats of the beetles of Madeira and the inferences to be drawn from them, while to the other two a brief reference has been already made.

Five essays are devoted to the theory of evolution, among which special attention may be directed to the one dealing with the question of the possibility of acquired characters being inherited, which appeared in the *Fortnightly Review* for 1893. At the conclusion of this article Dr. Wallace remarks "that no case has yet been made out for the inheritance of individually acquired characters, and that variation and natural selection are fully adequate to account for those various modifications of organisms which have been supposed to be beyond their power."

To many readers the three essays on anthropological subjects will perhaps prove the most interesting in the whole book. The first of these deals with the Polynesians and their migrations, the second gives an account of New Guinea and its inhabitants, and the third treats of the affinities and origin of both Polynesians and Australians. In the title of the second member of this trilogy the author has scarcely done himself justice, since, in addition to describing the Papuans, he gives a most interesting summary of the leading features of the mammalian and avian fauna of the largest island in the globe. The illustrations of some of the recently discovered types of birds of paradise in this article are among the most exquisite examples of photogravure that have come under our notice. Well selected, too, are the anthropological photographs with which these articles are illustrated, and especial attention may be directed to the juxtaposed portraits of an Australian

and a Yeso Ainu, which the author considers afford important evidence in favour of the Caucasian affinities of the former race. Mr. Wallace, in opposition to the views of the late Sir William Flower, likewise advocates a Caucasian descent for the brown Polynesians. The use of the bow and arrow by the Papuans, and not by either the Australians or the Polynesians, is, he remarks, a notable ethnical fact. It clearly, indeed, serves to differentiate the Australians from the Papuans and other Melanesians; but then, on the other hand, it might also be used as an argument that the Polynesians are related to the Malays, who likewise never use the weapon in question. It may be remarked as somewhat strange that, when the author alludes to the possession of the boomerang by races other than the Australians, he omits to mention its use by certain Indian jungle tribes.

With one article on the problem of instinct, and a second on human selection, the latter worthy the best attention of those interested in the well being and improvement (both physically and morally) of the human race, the first of these two most interesting volumes is brought to close.

In the second volume our remarks, as already said, will be restricted to the first two articles, one of which deals with how an ideal zoological museum should be constructed and arranged in the best manner for educating the public, while the second discusses how near an approach to this ideal is made by the museums of the United States. The author seems to be clearly of opinion that a most important, if not, indeed, the prime function of a museum should be as an educating medium. In his main ideas he is in accord with the opinions of the late Sir William Flower, and he points out that a perfect museum ought to embrace everything from the lowest worm to the highest product of human art and skill. He also advocates the exhibition of a comparatively limited number of specimens (which should be the best that money can obtain), in order not to confuse by multitude, and also that these should have ample space. The allotment of separate chambers to particular groups is likewise made a point, because, as he urges, a long gallery only serves to distract the attention of the visitor from the objects immediately before him to those ahead, and thus inevitably leads to hurry and an imperfect study. Lastly, but not least in importance, Dr. Wallace advocates the arrangement of zoological collections according to local faunas, instead of according to the affinities of the animals themselves.

Whether or no this faunistic arrangement should be adopted for the main exhibited series in a museum may be an open question; but there can be no question at all that such an arrangement should be displayed in every national museum. The American Museum of Natural History shows in one case the animals living within a fifty-mile radius of New York, and in a second the characteristic members of the European fauna; and nothing of this nature can be of higher educational value. With regard to limiting the number of specimens exhibited, a difficulty occurs, since a museum—at any rate in England—has at least two distinct classes of visitors for whom to cater. For the ordinary lover of natural history, as well as for the general zoological student, to say nothing of "the man in the street," a small number of specific representatives of various groups is not only sufficient, but forms the best kind of exhibit he can be shown. On the other hand, although the working zoologist will find what he requires in the study series, the sportsman—and in Britain his name is legion—expects to find exhibited every species and race of furred and feathered game he may encounter in the course of his wanderings. To find a *via media* out of this difficulty is a problem which will probably long continue to vex the mind of the museum curator; but, like other difficulties, it will one day have to be faced and conquered.

Our best wish to the many readers whom Dr. Wallace's two volumes will undoubtedly attract is that they may derive from their perusal an amount of interest and instruction equal to that which has accrued to the present reviewer in the accomplishment of his task.

R. L.

BRITISH BRAMBLES.

Handbook of British Rubi. By William Moyle Rogers, F.L.S. Pp. xiv + 111. (London: Duckworth and Co., 1900).

MR. ROGERS' "Handbook of British Rubi" is not a work likely to excite a wide interest. As the offering to his fellow "batologists" of "a diligent student of British brambles for nearly a quarter of a century," it appeals to a restricted circle. No general worker in the field of systematic botany can hope to master the fine distinctions which discriminate the great majority of the so-called species; in fact, the general systematist will see at once that the batologist and he are widely at variance as to the limitation of species, and that for purposes of comparison with those of other genera and of a comparative study of floras the 'species' of British Rubi are useless. Generally speaking a 'species' is to some extent a personal matter, sometimes varying considerably in different conditions of one and the same person; but the entities recognised by several workers in one group usually bear an appreciable relation to each other and to those of other groups. It is not too much to say that there is no comparison whatever between the species of the batologist and the species of the botanist.

In Sir Joseph Hooker's "Student's Flora," which we may regard as the expression of the views on the British flora of our greatest living systematist, four species of *Rubus* are recognised, namely, *R. Chamaemorus* (the cloudberry), *R. saxatilis*, a small low-growing, subalpine plant rare in the south and east of England; *R. Idaeus* (the raspberry), and *R. fruticosus* (the blackberry or bramble); under the last-named twenty-two forms or subspecies are enumerated. Bentham, in his "Handbook of the British Flora," has five species, *R. caesius* (the dewberry) ranking as a species, whereas in the Student's Flora it is regarded as a subspecies of *R. fruticosus*. Babington, whose manual is generally recognised as the best critical account of our flora, and who paid some attention to the *Rubi*, makes forty-eight species by raising to specific rank a number of forms of *R. fruticosus*. Mr. Rogers, by a further elaboration of the same species, admits one hundred and three, many of which are subdivided into subspecies or varieties.

Thus *R. anglosaxonicus* has four subspecies and *R. dumetorum* eight varieties, and of the latter Mr. Rogers says,

"Other undescribed forms of this aggregate no doubt exist in Great Britain, and a further study of these may possibly justify the addition of one or more new varieties to the preceding list."

Thirteen of the species and a fair proportion of the varieties and subspecies are peculiar to the British Isles, occurring mainly in very restricted areas. *R. durescens*, for instance, is known only in Mid-Derbyshire, and *R. mercicus* is "at present known with certainty only between Water Orton and Minworth, Warwickshire."

We do not wish to underrate the value of the work of Mr. Rogers and his fellow-batologists, who, moreover, are not wholly responsible for the present state of batology. They are disciples of Dr. W. O. Focke, of Bremen, whose epoch-making visit to England in 1889 is referred to almost as the missionary visit of an apostle. The handbook is a monument of patient toil and critical examination; each species, subspecies and variety is described with a care and fulness which many botanists would do well to emulate; notes on habitat are given, the distribution, if any, on the Continent is recorded, and there are also many remarks of a critical nature on the affinities of the form in question. An appendix contains a list of the botanical counties for which each species is recorded; and the thorny path of the student is somewhat eased by a key to the groups and a brief conspectus of the species which precede the detailed descriptions.

As a study in the variation of a highly variable species, the book is a store of valuable information, which, if carefully collated and arranged, might yield results of great interest, especially if more particulars as to habitat and environment were included. However, Mr. Rogers' aim has been to record and systematise, for the benefit of students of batology, facts already ascertained, and he has carried out his task in a manner which, except for a few details, is beyond criticism, and calls for the gratitude of all batologists present and to come.

A. B. R.

EXPERIMENTAL FRUIT-FARMING.

Report of the Working and Results of the Woburn Experimental Fruit Farm. By the Duke of Bedford and Spencer U. Pickering, F.R.S. Second report. Pp. v + 260. (London: Eyre and Spottiswoode. 1900.)

IN few departments of plant cultivation is empiricism more rampant than in the cultivation of fruit-trees. The methods of pruning and other cultural details have been handed down from our forefathers with little or no attempt to regulate them by scientific methods, whilst, in too many instances, absolute neglect has prevailed and fruit-growing has, in consequence, been deemed unprofitable at the very time when thousands upon thousands of barrels of apples are imported annually from the United States, Canada and Tasmania. In some cases this foreign supply comes in when our own crop is exhausted, but, speaking generally, a very large proportion of the fruit crop might be grown here just as well as in the States were our farmers endowed with the same business capacities as their brethren across the Atlantic. Recognising the importance of these facts, the Duke of Bedford has established near Woburn an experimental fruit-farm, where, under the directions of Mr. Pickering, experiments are being carried out on various cultural methods applied to fruit trees and to bush fruit. At the same time, demonstration plots are planted with a view of showing to the farmers what kinds of apples and other fruit trees may be grown in that particular locality with a reasonable expectation of profit.

The farm has now been established for five years. The first report, published three years ago, was naturally devoted largely to a general account of the ground and of the experiments then commenced. The present volume deals more largely with results. Those who have no leisure to investigate the statistical details will be able to glean a good general idea of their purport from the perusal of the table of contents and the general summary given in the appendix.

The experiments made with a view of destroying the currant-bud mite were very numerous and very unsatisfactory. Although at Wye College the use of hydrocyanic vapor has been found serviceable, it was found of no avail at Woburn. It would seem, however, that our efforts will be negative until we know more of the life-history of the mite. Perhaps the study of the manners and customs of the hazel-bud mite might furnish a useful clue to our knowledge of the nearly allied currant-bud mite.

Eighty-five varieties of strawberries were under observation, but it was not found possible to trace any definite connection between the amount of the crop they furnished and the meteorological phenomena to which the plants were subjected. Moreover, the results of the application of manures, artificial or natural, are stated to be "ambiguous," a fact which points to the inference that the soil is sufficiently fertile without the application of manure.

The results of pruning at various times and of differen methods of performing the operation are tested by weighing a certain number of leaves from the trees, and by measuring the height and girth of the trees. From these experiments, it would seem as if further time is required to estimate the value or otherwise of the different methods of pruning. Root pruning, a practice largely adopted by gardeners to check undue luxuriance and promote fertility, is made the subject of other experiments by Mr. Pickering and his lieutenant, Mr. Castle. Although root pruning acts as a check to vegetation, it generally also results in the formation of a large quantity of fibrous roots and root-hairs, so that the absorbent power of the roots must be increased, and we might have expected the vegetation to be correspondingly enhanced. There is a little inconsistency here which we hope the Woburn experiments may ultimately clear up.

Perhaps the most striking result yet obtained is that showing the injurious effect of growing grass round the fruit trees, the injury being attributed to the increased evaporation from the soil and the consequent exposure of the trees to drought. Many of our orchards are in grass, but as they are "fed off" by sheep the injurious results may, in a measure, be counteracted by the manure so supplied. Other experiments we can not here further allude to, but, in conclusion, we can but emphasise the

great importance of the experiments which are carried out by the munificence and public spirit of the Duke of Bedford. Each year their value and importance will be enhanced. If we might make one suggestion it would be that a corresponding series of experiments, though not necessarily on so large a scale, might be made on barren sand or some soil less naturally fertile than that at Ridgmont. MAXWELL T. MASTERS.

OUR BOOK SHELF.

Design in Nature's Story. By Walter Kidd, M.D., F.Z.S. Pp. ix+165. (London: James Nisbet and Co., Ltd., 1900).

HUXLEY pointed out that the Darwinian theory of adaptations was incompatible with "the commoner and coarser forms of teleology," but admitted that "there is a wider teleology, which is not touched by the doctrine of Evolution." But Dr. Kidd is not satisfied with this, and has written a little book to protest against the attempt of modern science to ignore what is called "Design in Nature." He does not trouble himself to define with any precision what he means by this phrase, but he seems to mean what is called "the directive intelligence of a personal God," and we can only repeat what has been said so often, that with this the scientific mood, as such, has nothing whatever to do, though it supplies some of the data with respect to which the philosophic mood may decide as to the validity and fittest formulation of the conception. When Weismann says, to the author's disgust, that the introduction of teleological principles is the ruin of science, he simply expresses the general conviction that their introduction is incongruous with the scientific method. Dr. Kidd does not seem to see that to oppose scientific and teleological interpretations is to oppose incommensurables.

The author gives examples of adaptations in plants, in animals, and in man, but Darwin's illustrations are far more convincing. He emphasises also "the adaptedness of environments for coming organisms," though it seems plain enough that only those organisms could come to stay who were relatively fit to survive in the given conditions. If the author will reconsider, for instance, the position expressed by W. K. Brooks in his "Foundations of Zoology," he may discover that he is tilting against a windmill, that Darwin did at least as much for teleology as Paley, and that our provisional theories of the rise and progress of adaptations suggest no reason whatever why the philosophers should not adhere to the teleological position. But these discoveries should have been made before publication. J. A. T.

Penrose's Pictorial Annual. Vol. vi., *The Process Yearbook for* 1900. Edited by William Gamble. Pp. xvi +112. (London: Penrose and Co., 1900).

THIS handsome volume will give the reader an excellent idea of the way in which photographs *can* be reproduced for illustration purposes. It is too often the case that either copies of photographs have to be made quickly or the paper on which they are printed is not of the most appropriate kind, so that the "reproduction" is by no means of a very high order. In this annual, however, the editor has taken great care that the art of reproduction should be given its full scope, and any reader cannot but admire the results as here displayed. From the beginning to the end of the volume we find innumerable illustrations, dealing with all kinds of subjects and reproduced by nearly as many processes. The illustrations are as nearly perfect as reproductions can be, and show that a sound practical knowledge has been utilised throughout. The editor states that "We have tried to show what photomechanical processes can do at the present time, and to present the specimens of the numerous British and foreign firms in a style which will bring out every quality in the plates." That this has been carried out in a highly satisfactory manner cannot be denied.

Many hints may be gathered from the numerous articles scattered throughout the volume, especially from that written by the editor on catalogue illustrations.

In conclusion it may be stated that every one interested in the subject of process work, and who wishes to know its position to-day, cannot do better than examine closely the examples displayed throughout the pages of this volume, which is a model of good printing and get-up.

Knowledge Diary and Scientific Handbook for 1901. (London: *Knowledge* Office, 1900.)

THIS publication is one which appeals more particularly to those interested in astronomy, and will doubtless prove a great convenience to actual observers for recording their observations, and to others for use as a private diary. There is a generous allowance of space for each day, and provision is made for recording correspondence. In addition, there are 120 pages of printed matter, consisting of the principal astronomical data for the year, a calendar of notable events, a variety of useful tables, and reprints of a few articles of more than passing interest which have appeared in *Knowledge*. Star maps, showing the aspect of the heavens for each month, are also given. As the recognition of the planets is apt to be a source of difficulty to beginners, it would be well in future issues to state the times of their rising and setting as well as of their southing, and to indicate their places month by month in connection with the star maps.

A Short Course of Elementary Plane Trigonometry. By Charles Pendlebury. Pp. xi+160. (London: George Bell and Sons, 1900.)

THIS short course is intended for those who do not require more than a very elementary knowledge of the subject. The treatment adopted is therefore very simple and the language plain. The book is divided into four parts. The first includes definitions, trigonometrical ratios, and multiple and sub-multiple angles, &c.; the second contains a short account of the use of logarithms and mathematical tables. In the third part the solution of triangles, determination of areas of triangles, and the treatment of circles and other figures associated with a triangle are dealt with. Part iv. contains the solutions of some of the more simple trigonometrical equations and also numerous questions on bookwork and answers to the many examples given in the book. As a first course for beginners the book should prove useful.

Lehrbuch der anorganischen Chemie. Von Prof. Dr. H. Erdmann. Zweite Auflage. Pp. xxvi+757. (Brunswick: Viewig und Sohn, 1900.)

THE first edition of this book, published two years ago, was noticed in these columns at some length. The present edition does not materially differ from it, but numerous additions of detail have been made in order to bring the book up to date. Conspicuous among these additions is information about the new gases—here called Edelgase, presumably from their relegation to Mendeleef's seventh group. A fine chromo-lithograph of the spectra of the gases has been added. If there is a want of connectedness and philosophy in Prof. Erdmann's book, there is certainly an abundance of interesting detail collected from a wide field, and on this must lie its chief claim to recommendation

LETTERS TO THE EDITOR.

[The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. *No notice is taken of anonymous communications.]*

Chemical Products and Appliances at the Paris International Exhibition.

I SEE that attention has been called in these columns to the excellence of the German catalogue of instruments of precision distributed at the recent Exhibition. It will be of interest if, as a member of the jury representing Great Britain for Class 87, I may be permitted to add that the German catalogue explanatory of the collective chemical exhibits of that country is also a remarkable production, worthy of a permanent place on our library shelves. Copies of this work, printed and got up in a highly artistic way with German text, were distributed among the members of the jury by my friend, Geh. Rath. Dr. Otto N. Witt, the titular member representing Germany on our jury. A French edition was afterwards to be had on application to the custodian of the German exhibits. The work consists of over 200 pages, each embellished with a coloured floral design as a heading, and contains a general introduction, giving an account of the development of German chemical industry, the value of the production in this branch of manufacture for the year 1897 being estimated at 47,395,132*l.* (947,902.645 marks). The introductory part, which is from the pen of Dr. Witt, is followed by a special part containing the history, an account of the nature of the products manufactured, the equipment of the factory and scale of production, and a list of the exhibits of each of the ninety firms represented in the collective exhibit. Those who visited the Exhibition and made an examination of the chemical exhibits of the various countries will have formed their own conclusions as to their respective positions in the scale of chemical industry. At any rate, it is not the object of this letter to institute invidious comparisons—I merely wish to point out that it is not only in instruments of precision that the German catalogue reveals the industrial eminence of that country.

R. MELDOLA.

Electricities of Stripping and of Cleavage.

IN the ordinary process of giving a glazed surface to photographic paper prints by leaving them to dry face downwards upon clean glass, enough electricity is, I find, developed at the moment of separation between the dry glazed print and its glass support to produce a pretty bright illumination in the dark. "Solio" and other gelatino-chloride printing papers being very liable to adhere obstinately to a glass plate in this process, I have only constantly employed it with albumenised printing paper, and have then often noticed strong electrical attraction between the glass plate and the freshly separated paper. Not all glass plates, but apparently only very hard unhygroscopic ones, with a low percentage of soda in their composition, serve the purpose well; and even on these the print must not be freed from superfluous water by any pressure, but by swinging the plate until the water is sufficiently expelled to leave the glass and paper adhering firmly to each other. The paper can be then further freed from water by wiping it on the back, very lightly, with a soft cloth, and any intrusive air-bubbles seen through the glass can be driven out by stroking the back of the print very lightly with the finger. Left then to dry quite horizontally with the paper upwards, the latter will in hot, dry weather or in a very dry, warm room separate itself at last more or less completely from the glass; but in ordinarily damp atmosphere, and cold weather, remains, though sensibly quite dry, adhering to it. The slightest warmth of sunshine or of a fire or gas flame applied to the plate is then enough to make the paper crisp, and leave the glass. This it does with audible clicks as the adhesion breaks up here and there, showing that a state of pretty strong tension prevails in the thoroughly dry paper and the coat of albumen until these can break loose from their support.

The tension is apparently strongest in the albuminous coating of the paper, since the paper curls in towards that face when it is liberated; and if the process of separation is observed on the face of the print, through the glass, the still adhering white parts of the paper have a greenish, and the loosened parts the ordinary yellowish tinge of such papers, in very perceptible contrast with each other. When well dried spontaneously in a warm, dry place, if, also, the rough back of the dry paper is rubbed smooth before gently warming it to strip it off, there is strong enough electrical attraction between the glass and the released paper to keep the latter flat against the glass while the separation spreads, with clicks and snaps of freeing from the edges, until soon, the tension in the film prevailing, the glazed and loosened print bulges upwards in the middle and its ends curl inwards. In the drum-like shape which it then sometimes assumes I have seen it rolling about on the under side of the warm glass plate, supported there for some minutes by the mutual electrical attraction between the dry paper and its glass support.

After trying in vain, for some months past, to see any luminous signs of this strong electrification, by taking the warmed plate when separation was commencing, into an adjoining darker room to watch the operation's progress, to-night, at last, the experiment has perfectly succeeded. The conditions in which it did so were not exceptionally favourable ones in any particular respects that I could notice, but a quickly toned, fixed and washed albumen paper print had dried slowly and thoroughly in a dry, warm place without loosening itself from the glass surface. The paper was not smoothed on the back before holding it pretty close to the dull hot coals of a low fire, which had scarcely time to more than slightly warm it, when clicking sounds announced that splitting from the glass surface had commenced.[1] A glance through the glass face showed that loosening from the glass at one end of the print had just begun, and the plate was immediately taken, for the paper to finish freeing itself, into perfect darkness in another room. Though but very slightly warmed, a little waving of the plate, with its transparent glass side upwards, up and down (which assists the parting by rapid drying and changes of temperature in the paper), presently advanced the cleavage a little step further, and this was marked by an audible snap, and at the same time by a light-flash at the released end of the print, bright enough to have been seen easily by sufficiently watchful eyes, from any part of the moderately large room. The same bright glow followed the line of yielding of the print, while it was then quickly seized by its loose end and stripped from the under side of the glass plate by hand, as a yellow or orange-coloured stripe of gauzy light, about half an inch wide, as bright as the first flicker of whiter gauzy light.

Considering that the tough coating of dry albumen seems to be stretched on its glass support with considerable strain and force of tension, which is slackened and released immediately behind its advancing line of severance from the rigid glass, perhaps the electric excitation may be due to friction of small rubbing surfaces of the loosened coat of albumen against the glass; and in that case the example may be one of electrification by a mechanical, rather than by a molecular form of cleavage like that observed in crystals, of one surface from another. In Becquerel's well-known experiment of the evolution of electricity and light when a thin lamina of mica is split into two thinner leaves, no definable forces of released tension, leading to electrification by friction of dissimilar portions of the crystal, can be resorted to as probable effective working sources in the mica, or in other crystals, of the electricities developed by their cleavage. But while no evident condition seems, in fact, to predetermine which of the two halves of a split leaf of mica should be found to receive a positive and which a negative charge from the electrifying forces which the cleavage exercises, the common experience that glass rubbed with silk is positively, and the silk negatively, electrified in a determinate and certain way could easily afford a test, and might furnish some assurance of the sufficiency of the above view's account of the origin in mechanical friction of the glass's and paper's opposite electrifications, if the two bodies, stripped asunder, are found to be endued with electrical charges of invariable kinds agreeing with those which glass and dried white of egg acquire when they are rubbed together. But I have not yet had an opportunity of putting the question to this test by the simple use of an electroscope, although the experiment could be easily performed with that appropriate equipment as the persistency of the charges on the glass and on the paper is plentifully long enough to allow of their complete investigation.

[1] These sounds are chiefly due to tough adhesions common at ragged points along the paper edges, and overcome from time to time by the spreading separation and increasing tension. Across the open print surface the separation spreads silently and smoothly, except across occasional spots of softened albumen with unduly tough adhesion, which may also there sometimes occasion snapping sounds in parting.

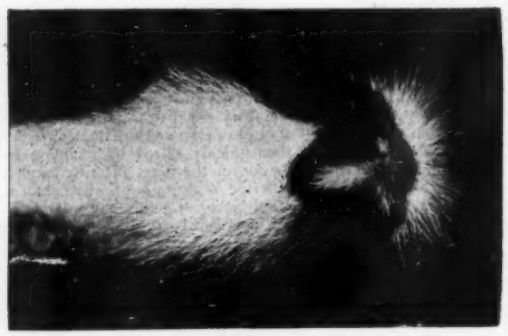
The momentary gleams of the electric light-play can be very easily observed by holding an albumen paper print thoroughly well self-dried on glass, paper side downwards, in a perfectly dark room over a hot room-stove to produce the paper's separation, and by stripping the print off downwards as soon as some edge of it has grown loose enough—probably with some signs of light—to allow it to be taken in the fingers. I have by this means now seen those brush and glow lights' flitting beams a second time, and there seems to be no difficulty of producing them in varied form and brightness by this method of proceeding.

A. S. HERSCHEL.

Observatory House, Slough, December 10.

Photography of the Static Discharge.

The accompanying photograph of the spark of a large static machine may possibly be of some interest to the readers of NATURE. The machine is a large Holtz, used in the electrical department of St. Bartholomew's Hospital. It consists of eight glass plates of twenty-nine inches in diameter, inclosed in a glass case. It is driven by a motor which is worked by the 100 volt alternating main which supplies the electrical department with its alternating current. The initial charge is obtained from a small Voss machine which is inclosed in the case of the Holtz. The photograph was obtained in the following manner. The machine was started and the brass knobs of the conductors adjusted to give a spark of about seven inches in length. The knobs were now tested in the usual way (by presenting a metallic point to the conductors) with reference to the



sign of their charge. A gelatine dry plate was then taken, inclosed firstly in an orange and then in a black envelope. The plate was placed between the knobs of the conductors in a line parallel with them and the sparks allowed to play over the envelope for a period of one second of time. The plate was then taken to the dark-room, developed and fixed in the ordinary way. The accompanying illustration shows the curious results obtained. A distinct break can be seen in the continuity of the sparks between the positive and negative poles. Round the positive pole the sparks are rushing off in a dense mass with a direction from the negative pole of the machine. At the line of separation of this dense mass of sparks is seen a depression as if the mass had been eroded by the negative charge, reminding one very forcibly of what happens to the positive carbon of the arc light. At the negative pole the sparks are much less dense and more fan-shaped, and radiate in the reverse direction to the positive sparks with the exception of a cone of sparks, which are much smaller, which approach the depression in the positive mass. This prolongation of small sparks towards the positive pole is seen in each of the photographs obtained. The results of the experiment are curious. I am unable to explain them, but think they are perhaps worthy of record.

St. Bartholomew's Hospital. HUGH WALSHAM.

Malaria and Mosquitoes.

As I was reading the very interesting article by Dr. Fielding-Ould on the "Malaria Campaign," which appeared in NATURE of November 8, I was struck by the fact that the use of the mosquito-netting he suggests as an efficacious preventive against malaria fever was already arrived at several years ago through nothing but experience in one of the malaria districts in Syria. The following is a translation of a letter published in vol. viii. (April 1884) of the *Muktataf*, an Arabic literary and scientific review, edited in Cairo, Egypt, by Drs. Sarrûf and Nimr :—

"To the Editors of *Al-Muktataf*.

"GENTLEMEN,—I have already had the chance of observing the spread of the malaria fever in Rashiya, both in the autumns of 1878 and 1883, and I noticed that one of the principal agents in effecting its spread was the mosquito. I have also noticed that all those who, at the time of the epidemic, took precautions against the mosquito bites escaped the fever, a fact well known in this part of the country. I therefore conclude that mosquito nets which completely cover the bed and prevent the entrance of mosquitoes are the best fever preventives in countries abounding in malaria marshes.

ABDELLA JABBOUR,

Rashiya.

Trusting the above will find a place in your esteemed paper,

N. Y. SARRÛF.

Cairo, December 7.

Can Spectroscopic Analysis Furnish us with Precise Information as to the Petrography of the Moon?

THEORETICALLY I think we may reply in the affirmative, but whether our means of observation are, as yet, delicate enough to give give us trustworthy results I leave to the investigation of your readers.

As the question is of considerable interest, pardon me if I enter somewhat into detail.

(1) If we had two smooth, plane, parallel mirrors, perfectly elastic, and a gas jet midway between them, we might first light the gas and then extinguish it without destroying the illumination, for, if the mirrors were perfectly elastic, the waves of light would oscillate between the two for ever with undiminished intensity. We know that this is not the case, therefore no known substance is perfectly elastic.

(2) If direct solar light fall upon a large mass of sandstone, part of it penetrates the mass as heat, and part is reflected, with a diminished velocity, so that we might expect, *a priori*, an apparent displacement of the Fraunhofer lines, as compared with the spectrum of direct sunlight.

(3) Similar results might be looked for with regard to limestone, basalt, &c., but not identical, unless we make the very improbable supposition that all solids are equally elastic.

(4) Hence it should be possible to construct a table of relative photo-elasticities so that if the substance were given its elasticity might be found by inspection, and *vice versâ*.

(5) Next, analysing the sunlight reflected from various regions of the moon, and referring to our table, we might hope for answers to the questions

(α) Are Tycho, Copernicus and the Appenines basaltic?

(β) Is the Mare Tranquilitatis the dried-up limestone bed of a saltwater ocean, or the dried-up sandstone bed of a freshwater inland sea?

I admit, at once, that the observations suggested are of extreme delicacy, but I cannot consider them insurmountable in an age which has witnessed the proof of the regression and subsequent approach of Sirius to the solar system by this very method.

W. J. KNIGHT.

Cork.

INTERNATIONAL CATALOGUE OF SCIENTIFIC LITERATURE.

AT the International Conference which met in London last June to discuss this subject, it was thought that the time had arrived when the great work of publishing a complete catalogue of all the scientific literature of the world might be undertaken with every prospect of success.

A Provisional International Committee was, therefore, appointed at the Conference to carry out the preliminary work, and this Committee reported the results of its labours to an International Council which met last week in the rooms of the Royal Society.

At this meeting, which took place on December 12 and 13, there were present:—Prof. B. Schwalbe, representing Dr. Milkau (Germany), Prof. G. Darboux, representing Prof. H. Poincaré, and Dr. J. Deniker (France), Prof. A. W. Rücker, Sir M. Foster, Prof. H. E. Armstrong and Dr. L. Mond (Great Britain), Prof. J. H. Graf (Switzerland), Dr. E. W. Dahlgren (Sweden), Prof. Korteweg (Holland), Dr. M. Knudsen (Denmark), Mr. Roland Trimen (Cape Colony), Dr. W. T. Blanford (India), Señor del Paso y Troncoso (Mexico), and M. Metaxas (Greece). Dr. Ludwig Mond represented Italy in the absence of Prof. Nasini. Sir Michael Foster was elected chairman of the meeting.

It is proposed that the annual cost of a set of seventeen volumes shall be 17*l.*, and on this basis it was announced that the number of sets subscribed for by the various countries was as follows:—

	Sets.
United States of America	68
Great Britain	45
Germany	45
France	35
Italy	27
Japan	15
Switzerland	7
Sweden	6½
Denmark	6
Holland	6
Norway	5
Mexico	5
Cape Colony	5
Canada	4½
Hungary	4
Portugal...	2
South Australia...	2
Western Australia	1
Victoria	1

One great difficulty in starting an enterprise of this magnitude is that a large amount of capital is needed to cover the preliminary expenses and to pay for the printing of the first set of volumes, and for other work which must be done before the grants from the various countries are received, and before any sales of the volumes to the public can be effected. This initial difficulty was met by the Royal Society, which generously offered to advance the necessary capital. This offer was accepted by the International Council, which expects to be in a position to repay the sum advanced during the next few years.

The Royal Society offered to act as the publishers of the catalogue, and to sign the necessary contracts with the printers and publishing agents. This offer was unanimously accepted by the International Council, which, after carefully examining the clauses of the proposed contracts, declared its approval of them.

The three principal countries which have not yet joined in the scheme are Russia, Belgium and Spain; and the Royal Society was asked by the International Council to address the Imperial Academy of Sciences of St. Petersburg on the subject, and also to take steps to induce the other countries to join in the catalogue.

A code of instructions for the use of all who are taking part in the preparation of the catalogue was considered, and, after some amendment, adopted.

In this connection the chief point discussed was whether it is desirable to publish complete lists of new botanical and zoological species. It was decided that lists of new species should be published, and that they should, as far as possible, contain all the additions to our knowledge in this direction made within the year.

It was also decided to include translations in the catalogue, but to indicate that they are translations. Schedules of classification for the subject indexes of the several sciences were adopted.

An executive committee was appointed, consisting of the four delegates of the Royal Society and the representatives of the four largest subscribers to the catalogue—France, Germany, Italy and the United States. Dr. H. Forster Morley was appointed director of the catalogue.

Finally, it was resolved to begin the work on January 1, 1901, and to include in the catalogue all literature published after that date.

FURTHER REMAINS FROM LAKE CALLABONNA.[1]

THE undermentioned Memoir is the second of a series, dealing with the remains of the great extinct vertebrates discovered in the Lake Callabonna in South Australia during the expedition already commented upon in our pages (NATURE, vol. lxi. p. 275, 1894), and now famous for having yielded the materials for a fuller knowledge of the osteology of the remarkable marsupial, colossus Diprotodon. The present contribution deals entirely with the great flightless bird Genyornis, which was found in association with this, and is for the most part an extended and illustrated account of portions of its skeleton, which the authors have already more briefly described in the Transactions of the Royal Society of South Australia and elsewhere. It is divided into two parts, a first dealing with the bones alone, a second containing an account of the surroundings and physical features of the Lake and the characters of its bed, of its geology, and the history of its investigation, all of which are special and detailed, and have for the greater part received prior consideration in our pages in the aforementioned article and in its predecessors therein referred to by the authors themselves (NATURE, vol. l. pp. 184 and 206), permission to quote freely from which they herein acknowledge.

It is with the first part of the Memoir we are chiefly concerned, and the newer facts it sets forth are the outcome of the results of comparison with the numerous remains described of those of allied genera mostly preserved in the Australian Museums. In dealing with these the authors pay a just tribute to the work and energetic enthusiasm of Mr. R. Etheridge, junr., the indefatigable curator of the Sydney Museum, whose Memoir on the subject in the "Records of the Geological Survey of New South Wales" is taken as the basis of their inquiry; and, as the outcome of this portion of the work, they have been led to associate with the Callabonna genus certain skeletal fragments, previously collected in South Australia, Queensland, and New South Wales, of Pliocene and Pleistocene age, especially a portion of a tibia from Mount Gambier, of a femur and some tibiæ from Normanville, of a tibia from the Paroo River, and of a fragment of a pelvis from the Canadian Gold Lead in New South Wales, most of which had been referred by Owen and Etheridge, junr., to the genus Dromornis.

The generic name Genyornis is expressive of the great size of the lower jaw, and a fuller description of this is, we presume, reserved for a promised detailed memoir in course of preparation. The present one treats mainly of the limb-bones, shoulder girdle and sternum, and the most noteworthy facts recorded are the numerical reduction of the phalanges of the outermost (fourth) digit to four, and the great slenderness, indicative of reduction, of the innermost or second, which, for the Ratitæ, are exceptional features. These characters notwithstanding, the authors, from a careful study of the measurements of the long bones and particularly of all that concerns the sternum, which is here for the first time fully described, regard the Emeu as the nearest living ally of this aberrant genus, and to the justice of

[1] "Fossil Remains from Lake Callabonna." Part II. (1) Genyornis Newtoni. (2) The Physical Features of Lake Callabonna. By E. C. Stirling, F.R.S., and A. H. C. Zeitz, C.M.M.Z.S. (Mem. Royal Soc S. Austr., vol. i. Part 2, pp. 41–80 and i.–xv., 6 photographic plates, 1900.)

their decision their photograph of the sternum, which is typically Dromæan, alone gives ample support.

Other remarkable features are the slenderness of the tarso-metatarsus and lower portion of the tibio-tarsus, and the general feebleness of the digits, the ungual phalanges of which are small, and believed to have borne "flattened nails rather than sharp and powerful claws, which could have been of little service for scratching purposes," the whole pedal skeleton, in fact, being in striking contrast with the massive proportions of the upper-leg bones and sternum. There is a moderate fibula well preserved.

Two small fragments of the coraco-scapula and some three or four ribs are described. Of the carpus there is no trace, and doubt besets a small bone referred to as a possible phalanx of the fore-limb. Concerning the anti-brachium, however, the radius and a possible ulna are preserved; and for the former the authors give measurements which show that, in contradistinction to that of all other Ratitæ, it far exceeds the humerus in length—a feature in respect to which the Emeu comes most nearly approximate but is still a long way behind.

Of remains in good preservation, or that, by the ingenious method of preparation adopted, upon which we have already commented (NATURE, vol. lxi. p. 276), could be rendered serviceable, those of the tibio-tarsalia were by far the most numerous; and in the present memoir the authors devote special attention to chemical action brought to bear upon those bones found nearest the surface, to which is due their friability and peculiar texture, associated with the formation of crystals, mostly of halite, admixed with gypsum, glauberite and alunite, by which they had become impregnated. The Memoir gives promise of further interesting results, and any one at home desirous of examining the remains will now find in the Geological Department of our National Museum at South Kensington a fine example of a hind-limb, in which the extraordinary diversity in bulk of the opposite ends of the tibio-tarsus, and the still more noteworthy slenderness of the innermost digit, must be seen to be appreciated.

SOME EXPERIMENTS ON THE DIRECT-CURRENT ARC.

ON Thursday last, December 13, Mr. W. Duddell read before the Institution of Electrical Engineers a paper on "Rapid Variations in the Current through the Direct-Current Arc," which he illustrated by experiments. Members of the Institution have already learnt from the experimental demonstration given by Mr. Duddell in 1898, when he read the paper by Dr. Marchant and himself on the alternate current arc, to expect from him most interesting experiments. Nor were they disappointed last Thursday. It is perhaps too much to say that the experiments then shown excelled in beauty and interest those exhibited on the former occasion, but they fully maintained the same high level of excellence.

Mr. Duddell has been carrying out experimental research on the arc for the past five or six years, and during the last two has, we understand, completed a series of experiments on the vexed question of the resistance of the arc. The questions dealt with in the paper read last Thursday were mainly side issues which had cropped up in the course of these researches. They embody, however, a number of most interesting and important results, many of which are suggestive of great possibilities.

The paper was divided into two parts, the first dealing with those cases in which the cause of the variation of the current was in the circuit outside the arc, the second with the cases where the cause was in the arc itself. Under the first heading, Mr. Duddell gave the results of experiments which he had made on the rapidity with which the P.D. between the electrodes of the arc, and the light emitted by the arc itself and the crater on the positive carbon, can follow variations of the current. The results show that the rapidity is surprisingly great. It is well known that with ordinary slow variations of the current through an arc a rise in current is accompanied by a fall in P.D. If the conditions of the arc were to remain unchanged, the P.D. would rise with a rise of current; but Mr. Duddell has found that the conditions of the arc can change as rapidly as 5000 times a second or more, and that when the current through an arc between *solid* carbons is suddenly increased it is only for the first 1/5000th of a second that the P.D. rises with the current. Messrs. Frith and Rodgers endeavoured, in 1896, to find the resistance of the arc by superimposing on a direct-current arc an alternating current having a frequency of 250 alternations per second, and measuring the change in P.D. thereby produced on the assumption that at this frequency the conditions of the arc did not change. The results of Mr. Duddell's work show that a frequency of at least 5000 alternations per second must be employed before such an assumption is justified.

It is remarkable also to find that the light emitted by the arc is affected by such small and rapid variations as Mr. Duddell found was the case. The light emitted by the crater and the vapour column varies sufficiently distinctly for a photographic record to be obtained even when the frequency of the superimposed variations in current is as high as 4300 alternations per second, and the amplitude of the variation as low as 3 per cent. of the mean.

When the current through the arc is altered, a change in the cross section of the vapour column is caused; and these changes, when the variations are rapid and periodic, give rise to audible sounds. Mr. Duddell has found that a variation of the order of one part in 10,000 from the mean current will alter the vapour column sufficiently to produce sound-waves. In this way an arc may be made to act as a telephone receiver by causing the varying currents in a telephone circuit to pass through the arc. An experiment was shown at the meeting in which the arc in the meeting room was used as a receiver for telephone currents from a transmitter spoken into in the basement of the building. The sounds were distinctly audible throughout the room, though the words could hardly be distinguished beyond a distance of some 10 or 12 feet. These results were obtained with a cored carbon arc—some 20–30 mm. in length and with a current of about 10 ampères.

The second part of the paper, dealing with changes of current produced by the arc, was full of interest and importance, and was illustrated by some very striking experiments. Mr. Duddell first described some experiments on the humming arc, in which he had found, by means of curves obtained with his oscillograph, that the P.D., current, and light emitted by the arc varied with the same frequency, this frequency being identical with the pitch of the note emitted. With the hissing arc Mr. Duddell finds a double variation—a large slow one, which is due, he considers, to the rotation of the arc as a whole, on which is superimposed a small rapid variation in the P.D. and current corresponding with the variation of the light emitted by the crater, this variation being produced, as Mrs. Ayrton has shown, by air obtaining access to the surface of the crater.

Perhaps the most remarkable points brought out by Mr. Duddell in his paper were those relating to the effects produced by shunting the arc with a condenser and self-induction. He has shown that the arc, if it be formed between *solid* carbons, when so shunted immediately becomes intermittent and emits a musical note. Mr. Duddell was led to this discovery by attempting to use the arc as a generator of alternating current by

rendering it intermittent by blowing it with a magnet. This method did not answer, as the intermittence was too irregular; and in order to try and overcome this irregularity Mr. Duddell shunted the arc with a condenser, and found that the arc immediately became intermittent without any blowing, and emitted a musical note. It appeared that the leads from the arc to the condenser possessed appreciable self-induction, and that if this were destroyed the musical note ceased. It thus became evident that a direct current arc between *solid* carbons, when shunted by a capacity in series with self-induction, supplied alternating current to the shunt circuit—the complete circuit consisting of the arc, self-induction, and capacity in series, the arc thus acting as a converter of direct into alternating current energy.

This effect can only be produced when the arc has the ratio of a small change in P.D. (∂V) to the corresponding change in current (∂A) *negative;* and when this ratio $\partial V/\partial A$ is numerically greater than r, the resistance of the condenser circuit. This was proved by Mr. Duddell with two experiments. With a cored carbon arc for which $\partial V/\partial A$ is positive he showed it was impossible to obtain a musical note. And using a solid carbon arc shunted by a condenser and self-induction and giving out a clear note, he showed that by increasing the resistance of the condenser circuit the sound steadily diminished and finally completely died out when this resistance became numerically equal to $\partial V/\partial A$. Any cause tending to dissipate the energy in the condenser circuit, such as, for example, the hysteresis of an iron wire core introduced into the self-induction, or any complete circuit, such as a sheet of iron or a closed ring of wire, brought near it, will also stop the note. This phenomenon suggests, as was experimentally demonstrated, a very simple and valuable method of obtaining oscillating currents of any desired frequency for experiments on magnetic space telegraphy.

Some experiments with metal arcs brought out two points of great practical importance. Mr. Duddell found that on shunting an arc between metal electrodes by a condenser the arc went out. The high rise of P.D. caused by thus suddenly breaking an inductive arc circuit may be sufficiently great to break down the insulation of the leads, as was shown by an experiment, in which a weak place in the insulation was introduced by bringing the two conductors to brass plates separated by a sheet of paper: every time the arc was shunted and put out, the paper was pierced by a spark. The same result was obtained by connecting the condenser permanently across the arc terminals and trying to strike the arc. This has important bearing on the practical use of metal switches, since it shows that the arcing at breaking should be encouraged rather than suppressed, since if there be capacity as a shunt to the switch-contacts and self-induction in the main circuit, a high rise in P.D. will occur, and may cause serious damage to the leads. As another instance of the practical application of this effect, Mr. Duddell showed that, when using an induction coil, a far longer spark could be obtained if the connections were made so that the contact maker first broke the circuit and then shunted a condenser across the gap to blow out the spark, instead of, as has always hitherto been done, having the gap permanently shunted by a condenser.

Mr. Duddell concluded his paper by showing that the note emitted by a musical arc could be tuned by adjusting the self-induction and capacity in the shunt circuit. A keyboard was arranged which shunted different capacities and self-inductions across the arc, and by this means two complete octaves were obtainable. Four arcs were arranged in series to increase the loudness of the sound, and a very distinct and not unmusical rendering of "God Save the Queen" was played on them.

The Central Technical College may well be congratulated on the work on the arc that has been done in its laboratories. Within the last two years there have been four most important papers on this subject read before the Institution of Electrical Engineers—Messrs. Duddell and Marchant's paper on the Alternate-current Arc, Mrs. Ayrton's paper on "Hissing Arcs," her paper at the Paris Congress on the "Light given out by the Direct Current Arc," and the paper by Mr. Duddell above described—all emanating from the College, and each contributing in no small degree to the elucidation of the many very difficult problems which the arc presents.

A BIRD-BOOK FOR YOUNG PEOPLE.[1]

WHETHER designedly or no, this attractive little volume is fortunate in the time of its appearance, since it forms an appropriate Christmas gift to young persons of both sexes interested in observing the ways of the birds of their own neighbourhood. And it is not even necessary that such young people should be resident in the country to appreciate the book, for the author, as in his account of the gulls on the Thames in winter, shows that there is much to be learnt with regard to bird-life even by the dweller in the metropolis. The appearance of a bird-book of this nature at the Christmas season is also appropriate in that it tends to draw attention to the severe hardships our feathered friends have frequently to suffer at this time of year, and thus attracts sympathy and attention to their wants.

To those of our readers who are familiar with the Messrs. Kearton by their previous works, no recommendation will be necessary in the case of the volume before us; while to those who have yet to become acquainted with the earlier literary and artistic efforts of these gentlemen, their new production will come as a welcome surprise. For although primarily intended for young people, it must not for a moment be supposed that the author's latest volume is not calculated to interest readers of more mature years. Indeed, the beauty and attractive character of the illustrations (two of which, by the courtesy of the publishers, we are enabled to reproduce) are alone quite sufficient to render the volume acceptable to readers of all classes and all ages. Mr. C. Kearton seems, indeed, almost to have surpassed himself, not only in the execution of the photographs, but in the interesting phases of bird-life and bird-architecture he has portrayed. All the photographs, it appears, have been specially taken for this particular volume, and as they reach one hundred in number, while their *venue* extends from the Thames Embankment to the Hebrides, some idea may be gathered of the amount of time, labour and money expended in its production.

A feature of the book is the attention devoted to nests, eggs and young birds; and although the style is essentially popular and suited to the capacity of the readers for whom it is primarily intended, older ornithologists will scarcely fail to be interested in the chapters on these subjects. In particular we may draw attention to the eight photographs on p. 99, the first of which represents a blackbird's egg on the day previous to hatching, and the other seven the young bird from day to day. By a careful arrangement and adjustment of the camera, the young bird was photographed to the same scale, and the marvellous rapidity of its development—especially between the fourth and seventh day of its existence—will come almost as a revelation to many readers. Unfortunately the further progress of the daily portraiture was brought to an abrupt termination by the unwelcome attentions of a cat. The subject is, however, full of promise, and one worthy to be taken up by other photographers.

[1] "Our Bird Friends: a Book for all Boys and Girls." By R. Kearton. With photographic illustrations by C. Kearton. Pp. xvi + 215. Illustrated. (London: Cassell and Co., Ltd., 1900.)

The precautions adopted for concealing their eggs while birds are temporarily absent from the nest claim a considerable share of the author's attention; particular interest attaching to the description and illustration of

FIG. 1.—Eggs of the Ringed Plover. (From Mr. Kearton's "Our Bird Friends.")

the manner in which moorhens are in the habit of bending down some of the adjacent reeds in order to prevent the eggs from being seen from above. Not less attractive are the illustrations showing the contrast in the appearance of the nest of the eider-duck when just vacated by the parent bird and when the eggs are enveloped in a mantle of fleecy down. Other illustrations display the adaptation of the eggs of the plover tribe to their environment, as well as the economy in space obtained by the clutch of four being placed with their narrow ends pointing inwards, both these features being admirably displayed in the annexed photograph of a ringed plover's nest. While on the subject of eggs it may be mentioned that some confusion is, we think, likely to occur in identifying which is the raven's and which the curlew's egg in the photograph on p. 80. And it may be added that, on the same page, *Epyornis* is not the way to spell the scientific name of the extinct Malagasy roc, which is compounded from the Greek ἄιπυς.

Another subject to which the author directs the attention of his readers is the connection between the structure and form of feathers and the uses they are intended to subserve; and here, again, the illustrations admirably assist in the interpretation of the letterpress. After describing the manner in which a gannet dashes into the water in its headlong descent when in pursuit of prey, Mr. Kearton proceeds to observe that "the shock produced by such a heavy bird suddenly striking the surface of the ocean after descending from a considerable height at great velocity would kill some species of smaller size on the spot. But the gannet has been properly equipped for its task. The shafts and vanes of its breast feathers have been tremendously thickened, and their quills are buried in a quarter-inch-thick pad of very close-set down, which acts like a buffer when its wearer strikes the surface of the sea."

Contrasted with this are the "fluffy" and loosely-attached feathers on the breast of the heron, which fishes while standing, and therefore needs no breast-plate.

In his preface the author tells his young readers how, when a child, he was delighted by bird-stories told by his grandfather. "They," he adds, "will enjoy a great advantage over me in being able, through the achievements of my brother's camera, to examine accurate pictures of the birds living, loving and labouring amidst their natural surroundings." No words of ours can add aught to this modest description of the most attractive feature of a charming book.

R. L.

HUXLEY MEMORIAL.

WE have received a copy of the final report of the Huxley Memorial Committee, which announces the completion of their task, and is accompanied by a full donation list, signed on behalf of the committee by the Hon. Treasurer and Secretary. It shows the cost of the statue to have been 1814*l.*; of the dies for the medal 26*l.*, inclusive of all that pertained to each; and this, with the sum of 201*l.* for total working expenses, and the balance of 1126*l.*, paid to the Board of Education as an endowment for the medal at the Royal College of Science, brings the total amount received and expended to a little over 3450*l.*, as compared with the Owen Memorial, which realised 1100*l.*, the Darwin rather more than 5000*l.*, and the Jowett about 10,000*l.*

The statue we have already described (NATURE, vol. lxii. p. 12), and of the medal for the Royal College of Science and the arrangement for the production of a memorial medal at the Anthropological Institute, to which we alluded at the same time, the report contains nothing that is new. It concludes with the thanks of the committee to the Hon. J. Collier for the gift of a portrait of the late Prof. Huxley to the National Portrait Gallery, in lieu of their inability to provide one.

The number of persons of distinction of all nationalities who ultimately consented to join the "General

FIG. 2.—Arctic Tern guarding her nest. (From Mr. Kearton's "Our Bird Friends.")

Committee" was close upon 750, and of these one-third were foreigners, 33 colonials. All but 60 of them subscribed, and the total number of contributors was

901, exclusive of local committees, societies, institutions and field clubs, each of which embraced a number of donors, and of which there were 22, making in all a total of 923 entries on the list, and of over 1000 individual subscribers. The sum raised by local subscription was 351*l.* Leeds heads the list with 54*l.*, Calcutta follows with 51*l.*, the New York Academy with 50*l.*, New Zealand contributes 30*l.*, Leicester 25*l.*, South Australia 21*l.*; and these, with Boston, U.S.A., Bristol, Cheltenham, Chester, Chicago, Chili, Ealing, Nebraska, New South Wales, New York, Paris, Servia, St. Petersburg, Upsala, Warrington, and Washington, embrace the chief colonies and centres in this way represented, together with the National Sunday League and the students of the Royal College of Science. The list includes the names of individuals resident in extreme latitudes and on the opposite sides of the globe, the sums contributed ranging from 100*l.* to half-a-crown.

The Executive Committee (of which we published a list in NATURE, vol. liii. p. 186) held twelve meetings, under the chairmanship of Lord Shand, and duly appointed sub-committees of their number for the carrying out of details. Of the subscribers, 48 died during the interval of payment and publication of the list, and of the executive, two—viz., Sir E. Frankland and Sir W. Flower, passed away before the completion of their task. Four members did not attend a meeting at all.

Concerning the statue, it may be placed on record that the late Prof. Max Müller early expressed in writing the desire that Huxley and Tyndall should be memorialised together, as are Goethe and Schiller at Weimar.

The medal, which we have not before described, bears on the obverse a profile portrait, with name in full and dates of birth and death; on the reverse a female figure with a lighted lamp in the left hand, and a laurel wreath in right, which she is about to deposit on an altar bearing the word ΕΠΙΣΤΗΜΗ, the whole backed by the foreshortened façade of the Royal College of Science. The designs for the medal were obtained by prize competition, and of the sixty-two persons who applied thirty-four competed. The premiated designs were twice the diameter of the dies (viz. 5 inches), and silver replicas of them, presented to the Royal College of Science, hang in Huxley's work-room, now a research laboratory bearing his name, beneath his portrait by Legros, and surrounded by personal relics and his working scientific library and effects, in themselves second to no memorial to his labours.

Specimen copies of the medal have been presented to Mrs. Huxley, to the British and South Kensington Museums, and, conjointly with an enlarged copy of the obverse, to the Royal Society, for their respective collections. By purchase at the cost of production, there have been acquired two sets of impressions by continental museums, and copies of the obverse in various sizes, to the number of thirty-six, by subscribers to the fund in many parts of the world.

Among the proposals for the once contemplated third object of memorial, of which the amount subscribed did not admit, there were submitted in writing suggestions for a Studentship (1) at the Royal College of Science; (2) at the Zoological Gardens, in recognition of Huxley's services to the Society, and of his connection with the foundation of its Prosectorship; for (3) a Scholarship at one of the Universities, to be open to all boys of the United Kingdom, and under the control of the Royal College of Surgeons (with an offer of 50*l.* if acted upon); for a Professorship (4) of Anthropology, and (5) of Hygiene; and (6) for a silver medal to the size of the original design for award by the Royal Society.

NOTES.

THE following have been nominated presidents of sections for the Glasgow meeting of the British Association, September 11–18, 1901: A (Mathematical and Physical Science), Major P. A. MacMahon, F.R.S.; B. (Chemistry), Prof. Percy Frankland, F.R.S.; C (Geology), Mr. John Horne, F.R.S.; D (Zoology), Prof. J. Cossar Ewart, F.R.S.; E (Geography), Dr. H. R. Mill; F (Statistics and Economic Science), Sir Robert Giffen, K.C.B., F.R.S.; G (Engineering), Mr. R. E. Crompton; H (Anthropology), Prof. D. J. Cunningham, F.R.S.; I (Physiology), Prof. J. G. McKendrick, F.R.S.; K (Botany), Prof. I. Bayley-Balfour, F.R.S.

IN accordance with a resolution which was passed by the General Committee of the British Association at the annual meeting held last September at Bradford, the Council of the Association have recently considered the advisability of establishing a separate section for education. We are informed that the Council have decided that a section of educational science shall be established, but that the section shall not necessarily meet each year. The first meeting of the section will be held at the Glasgow meeting, which will commence on September 11, 1901.

FOR the purposes of a National Physical Laboratory, the Queen has granted to the Royal Society Bushey House, Bushey Park, which was formerly occupied by the Duc de Nemours.

THE Linnean Society has undertaken the collection of title-slips for the United Kingdom of Great Britain and Ireland as regards botany for the International Catalogue of Scientific Literature. All botanists are asked to support the endeavour to compile a complete record. Societies and other publishing bodies are requested to help by sending their issues as soon as possible after publication, either by gift, loan or exchange, so as to co-operate in producing a yearly record of botanic literature throughout the world. Communications for the catalogue should be addressed to Mr. B. Daydon Jackson, Linnean Society, Burlington House, London, W. Other scientific societies will, we presume, render similar assistance to the work of the International Council.

A FEW weeks ago the new anthropological collections in the American Museum of Natural History in New York were opened to the public, and these valuable collections now occupy five halls, and others are being provided. We learn from our contemporary, *Science*, that the accessions to the anthropological collections of the museum obtained during the last three years have largely been due to extended scientific research undertaken by the institution. In this respect the methods of the American Museum of Natural History differ considerably from those pursued by a number of other institutions. It has not been the policy of the museum to accumulate rapidly and indiscriminately more or less valuable specimens collected on trading expeditions or purchased from dealers; but an endeavour has been made to build up representative collections and to obtain, at the same time, the fullest and most detailed information in regard to specimens, so that each addition to the exhibit of the museum can be made thoroughly instructive and will represent a material contribution to science. There is no doubt this is the best way to build up a museum, and it is to be deplored that the various museums of the British Islands do not follow the example so worthily set by this and other American museums. Our English method is rather to wait like a spider in its web in the hope that something will eventually be caught; in the meanwhile, other institutions are intelligently collecting wholesale in diverse interesting regions, while we are content with occasional specimens which usually have no history, or at most a very imperfect one, and for these we often have to pay a stiff profit to a dealer.

KING OSCAR OF SWEDEN AND NORWAY has given a sum of 9,000kr. towards the archæological researches of Dr. L. Kjellberg in Asia Minor and the island of Lesbos.

DR. E. VON DRYGALSKI, leader of the German Antarctic Expedition, has been elected an honorary corresponding member of the Royal Geographical Society.

PROF. ARTHUR THOMSON, professor of human anatomy in the University of Oxford, has been elected professor of anatomy in the Royal Academy.

M. PAINLEVÉ has been elected a member of the section of geometry of the Paris Academy of Sciences in succession to M. Darboux, who has been appointed permanent secretary for the sections of mathematical sciences.

A SCHOOL of Forestry has been established in connection with Yale University, under the direction of Prof. Toumey. Its home will be the residence and grounds of the late Prof. Marsh, which he bequeathed to the University for a botanical garden.

THE Botanical Department of the British Museum has recently acquired M. Bescherelle's herbarium of exotic Musci and Hepaticæ, consisting of 14,800 specimens of the former and 3500 of the latter family. It contains a very large number of type-specimens.

PROF. B. D. HALSTED has been elected president of the Botanical Society of America for the coming year. The *Botanical Gazette* states that an important step has been taken by the Society in appointing a committee to consider the best means of realising the purposes of the Society in the advancement of botanical knowledge. Among other matters the committee will consider the uses to which the accumulating funds of the Society may be put.

A KINSWOMAN of Faraday has made over to the Browning Settlement a ten-roomed house at East Dulwich, to be used as a home of rest and change for the poor, and to be called the Michael Faraday Home. To fit the Home for permanent use, the sum of 150*l.* will have to be spent on alterations and repairs. The annual cost of maintenance and hospitality will be at least 100*l.* To meet this outlay an appeal has been made for funds, and it is hoped that men of science will give their support to an object which would have had the sympathy of Faraday, and which will stand as a memorial to him in his native parish. Subscriptions should be forwarded to the Warden, Robert Browning Settlement, Walworth, London, S.E.

WE see in the *Athenæum* the announcement of the death of Dr. William King. In 1857, after graduating at Galway, Dr. King went to Calcutta to join the Geological Survey Department of India, where he spent thirty-seven years, during the latter six of which period he was Director of the Geological Survey Department of India, having succeeded Dr. Medlicott. During the seven years of his directorship considerable progress was made by the Survey in the prospecting and development of the coal, oil and tin areas of the Punjab, the North-West Provinces and Burma, and in the elucidation of the complicated geological structure of the North-West Himalayan salt range and the Baluchistan formations.

A DANISH expedition, composed of Lieutenant La Corn, leader, MM. Middilbo and Kofoed, physicists, and the artist Count Harald Moltke, left Copenhagen recently for Finland *via* Christiania, Trondhjem and Vadso with the object of studying the Aurora Borealis. The chief station will be established at Utsjoki, in North Finland, where the expedition will remain three months. Spectrum and magnetic researches will also be carried out. The expedition is the second of its kind dispatched under the auspices of Dr. Adam Paulsen, director of the Copenhagen Meteorological Institute.

SIR JOHN CONROY, Bart., F.R.S., whose death at Rome occurred on December 15, will be missed in the University and city of Oxford. He was educated at Eton and Christ Church, and obtained a First Class in Natural Science in 1868. When he was elected a Fellow of the Royal Society in 1891, he was lecturer in physics and chemistry in Keble College, and an assiduous student of experimental science. Among the subjects of his contributions to science are the dioxides of calcium and strontium, the polarisation of light by crystals of iodine, the light reflected by potassium permanganate, the distribution of heat in the visible spectrum, and experiments on metallic reflection.

NEWS has just reached us that Prof. John Gardiner, who directed the department of biology in the University of Colorado at Boulder, Colorado, from 1889 to 1898, died from consumption on November 26. Prof. Gardiner was thirty-eight years of age and a graduate of the University of London, and in 1887 he occupied the British Association's table at the Naples Biological Station. He was an enthusiastic student of biology, a man of rare culture in other lines, a fine lecturer, and was prevented from original work only by bodily weakness and the necessities of the large department over which he presided.

WHEN observations are being made by members of the Antarctic expeditions next year, it is important that as many similar and simultaneous observations shall be recorded in North Polar regions. Several Arctic expeditions will probably be in the field, and the leader of one of them, Mr. E. B. Baldwin, who has recently arrived in England, is making arrangements to carry on as much scientific work as is practicable for a private expedition. In an interview with Reuter's representative he stated that as Lieut. Peary and Captain Sverdrup are both in Greenland, his Polar route will probably be by way of Franz Josef Land. The expedition will number at least twenty to twenty-five men, mostly Americans. Two ships will be employed in the expedition, one to return home after the Arctic regions have been entered, and the other to proceed as far north as possible. Both will start at practically the same time. These vessels will be of the whaler type, such as are usually employed in Arctic work. The exact date and point of departure of the expedition will depend upon the developments of the coming spring with regard to Peary and Sverdrup.

REPLYING to questions asked by Mr. Seton-Karr in the House of Commons on Thursday last, Viscount Cranborne said that regulations for the preservation of wild animals have been in force for some time in the several African Protectorates administered by the Foreign Office as well as in the Sudan. The obligations imposed by the recent London Convention upon the signatory Powers will not become operative until after the exchange of ratifications, which has not yet taken place. In anticipation, however, steps have been taken to revise the existing regulations in the British Protectorates so as to bring them into strict harmony with the terms of the convention. The game reserves now existing in the several Protectorates are:—In (*a*) British Central Africa, the elephant marsh reserve and the Shirwa reserve; in (*b*) the East Africa Protectorate, the Kenia District; in (*c*) Uganda, the Sugota game reserve in the north-east of the Protectorate; in (*d*) Somaliland, a large district defined by an elaborate boundary line described in the regulations. The regulations have the force of law in the Protectorates, and offenders are dealt with in the Protectorate Courts. It is in contemplation to charge special officers of the Administrations with the duty of watching over the proper observance of the regulations. Under the East African game regulations only the officers permanently stationed at or near the Kenia reserve may be specially authorised to kill game in the reserve.

DR. BENJAFIELD, a medical man who has resided for the last twenty-seven years in Tasmania, described the advantages of the Colony as a health resort, at the Imperial Institute on Monday. He said that he was struck, on his arrival in Tasmania, with the almost complete absence of consumption and bronchitis, and it was now three years since he had signed a certificate of death from the former disease. Last year the rural mortality of Southern Tasmania was only 8·8 per 1000. In Hobart 2261 hours of sunshine have been recorded in one year, as against 1158 at Oxford in England. The climate of the Colony is one of the most even and excellent in the world. The atmosphere is pure, clear and crisp, and the general prevalence in the air, as indicated by the characteristic odour, of the essential oil of the eucalyptus tree, existing in abundance in the Colony, especially near Hobart, appears to exercise a direct antiseptic influence against deleterious organisms of all kinds.

WE have received from the *Deutsche Seewarte*, Hamburg, the ninth volume of meteorological observations made at stations beyond the sea. The observations are taken three times daily with duly verified instruments, and form a very valuable contribution to the climatology of various distant parts of the globe. Some of the stations in Labrador have been in regular operation since the time of the international polar expeditions in 1882–3, and are the more important as they lie in the track of the barometric depressions which pass from the Canadian shores into the Atlantic. Wherever the German nation gets a footing abroad, scientific investigations, and especially meteorological observations, are undertaken; in addition to the stations in Labrador, the present volume contains observations at Tsing-chow, Apia, Nauru (Pleasant Island), Ralum (New Pomerania), Mogador, and several stations on the west coasts of Africa. Observations are also being made in the German East African Protectorate, and will, it is hoped, be published in the next parts of this useful work.

THE November issue (vol. vi., No. 2) of the *Journal* of the Marine Biological Association of the United Kingdom contains an extremely interesting and important report on the fauna of the Salcombe Estuary, which has been drawn up by Messrs. E. J. Allen and R. A. Todd, with the assistance of several specialists. Salcombe Harbour possesses an exceptional zoological interest in that it was the hunting-ground of George Montagu in the earlier years of the century, and is consequently the type locality for a considerable number of British marine animals. Partly for this reason and partly because previous visits had demonstrated the richness of its fauna, the harbour was selected as a promising field for a systematic zoological survey, which was undertaken during the past summer. The authors state that the present report, from which the "plankton" is excluded, "consists almost entirely of a record of facts with regard to the nature and distribution of the fauna as we have found it during the present summer, consideration and discussion of these facts and comparison with the conditions prevailing in other localities being held over until further investigations on a similar plan have been carried out elsewhere." It does not appear that any new species were obtained.

BOTH to fishermen and to naturalists the article by Mr. W. Garstang, dealing with the plague of octopus on the South Coast and its effects on the crab and lobster fisheries, which appears in the *Journal* of the Marine Biological Association, will appeal strongly. Till the spring of 1899 the common octopus has been comparatively rare in the Plymouth neighbourhood for the last decade or so, as much as half-a-sovereign having been paid for a specimen. At that epoch, however, a marked increase in the numbers of this voracious mollusc was noticed, and during the year just closing it has appeared in such hosts as to cause widespread disaster to the shell-fish industry on both sides of the channel. Several newspaper paragraphs are quoted in evidence of the serious nature of the plague, which the author is inclined to believe is in part due to the exceptional heat of recent summers.

THE Italian earthquakes have formed the subject of a memoir by Perrey and of several detailed studies by Prof. G. Mercalli. Very numerous notices are also to be found in scientific journals, in literary and historical works, in newspapers and in books now become rare. The materials from these various sources are collected and discussed in a valuable work by Dr. M. Baratta, recently published. It consists of three parts. The first is a catalogue of 1364 of the more important earthquakes from the beginning of the Christian era to the end of 1898. In the second the seismic history of different districts is investigated, while the third contains a bibliography of more than 1600 papers, &c., on Italian earthquakes. The first two parts are illustrated by 136 seismic maps.

IN *Die Umschau*, Herr A. Stolberg gives an account of the last ascents of Count von Zeppelin's navigable balloon. The paper is illustrated by diagrams showing the modifications introduced into the construction of the machine since the earlier ascents, from which it appears that the suspended platform supporting the sliding weight used in maintaining longitudinal balance has been replaced by a latticed girder arrangement from which the weight is suspended, and, moreover, the steering arrangements have been considerably altered. The author estimates the speed of propulsion relative to the air at about 8 metres per second; and the total weight of the machine at about 10,200 kilogrammes, say ten tons.

THE latest invention in connection with wireless telegraphy is an apparatus designed to warn ships of their approach to a danger in times of fog or places where a simpler system of signalling is not practicable. The contrivance consists of a revolving wheel, having teeth of varying size, which, as it revolves, operate a Morse key connected with wireless telegraphy transmitting instruments, and according to the length of time they keep it depressed cause long or short signals to be transmitted. These signals represent the dashes and dots of the Morse code, and hence it is easy to dispose the teeth of the wheel so that any place sends out signals which spell its name. The wheel, which may be rotated by an electric motor or by clockwork, can be arranged to signal every minute or two or continuously, as desired, the idea being that it should be put into operation whenever bad weather comes on. In this way any place can be made the centre of a zone of influence, practically of any required extent, so that all ships coming within it will be notified of the fact by the ringing of an electric bell and the reception of a message giving the name of the place, provided they are fitted with apparatus for detecting the electric waves.

MR. GUSTAV FISCHER, Jena, has commenced the publication of the second revised and enlarged edition of Prof. A. Lang's "Lehrbuch der vergleichenden Anatomie der wirbellosen Thiere." The new edition will be in three volumes, the first containing four parts, the second three parts, and the third two. The part just issued is the first of the third volume, and in it Dr. K. Hescheler deals with the mollusca.

"Appendix No. 1," for 1901, of the Kew *Bulletin of Miscellaneous Information* consists of a list of the seeds of hardy herbaceous annual and perennial plants and of hardy trees and shrubs which, for the most part, have ripened at Kew during the year 1900. These seeds are not sold to the general public, but are available for exchange with colonial, Indian and foreign botanic gardens, as well as with foreign correspondents of Kew. No application for a share in their distribution, except from remote colonial possessions, will be entertained after the end of March.

In the September number of the *Bulletin de la Société d'Encouragement pour l'Industrie Nationale*, N. S. Kournakow gives an account of his investigations on the alloys formed by sodium and potassium with mercury and of sodium with cadmium, lead and bismuth. The method employed was the determination of the temperature of fusion. Curves are drawn representing the variation of the temperature of fusion with the composition, and in all cases these curves are characterised by very distinct temperature maxima. In the case of the combination sodium and mercury, no less than seventy-five experiments have been carried out, each with a different proportion of the components. The maxima of temperature referred to are remarkably high—346° C. in the case of sodium and mercury, and 269·7° C. in the case of potassium and mercury, and the composition of the alloy corresponding to these temperatures is exactly represented by the formulæ $NaHg_8$ and KHg_8. The freezing-point depression curves which proceed from these temperature maxima are shown to extend through large temperature intervals. In the case of $NaHg_8$ the curve extends from 346° C. to 218° C. on addition of sodium, and to 155° C. on addition of mercury. The combinations of sodium with cadmium, lead and bismuth are also distinguished by very high temperature maxima, these being respectively 395°, 420° and 720° C., whereas the melting-points of the pure metals are Na 96°, Cd 322°, Pb 326°, and Bi 268° C. These characteristic temperatures correspond exactly with the formulæ $NaCd_2$, Na_2Pb, and Na_3Bi. The author draws attention to the similar phenomena which have been observed with the combinations—aluminium and gold, aluminium and antimony—and concludes that in these latter the aluminium functions as an alkali metal, giving rise to the same peculiarities as sodium and potassium in the alloys investigated by himself.

In Prof. Cook Wilson's letter on the formula of inverse probability (p. 154) the following corrections should be made, though they do no not affect the fundamental argument: In line four of letter, for C_r and P_r read C_n and P_n; in line six, for p_r read p_n; p. 155, col. 2, line 13, for "in reality" read "on reality"; in penultimate paragraph, the last word, "strong," should be "strongest"; and in the eighth line from end, "the head" should read "this head." Finally, Prof. Wilson wishes $\frac{p_r P_{r'} x}{\Sigma p P}$ (line 19, col. 1, p. 155) to read $\frac{p_r P_{r'} x}{\Sigma p P x} = \frac{p_r P_r}{\Sigma p P}$.

From Mr. W. Engelmann, Leipzig (London: Williams and Norgate), the following scientific works have been received:—The third edition of A. de Bary's "Vorlesungen über Bakterien," revised and partly rewritten by Prof. W. Migula; Part i. of "Studien über die Verbreitungsmittel der Pflanzen," by Dr. M. Kronfeld, dealing with fertilisation effected by wind; and two parts of "Das Pflanzenreich," a conspectus of the vegetable kingdom, edited by Prof. A. Engler under the auspices of the Prussian Imperial Academy of Sciences. The plants described in these parts belong to the Musaceæ, Typhaceæ and Sparganiaceæ.

The additions to the Zoological Society's Gardens during the past week include a Chimpanzee (*Anthropopithecus troglodytes*, ♀) from West Africa, presented by Captain W. G. Ambrose; a Mozambique Monkey (*Cercopithecus pygerythrus*) from East Africa, presented by Mr. W. J. Langton; a Lesser White-nosed Monkey (*Cercopithecus petaurista*) from West Africa, presented by Miss L. Harold; a Stair's Monkey (*Cercopithecus stairsi*, ♂) from the Lower Zambesi, presented by Miss J. C. S. Purves; a Green Monkey (*Cercopithecus callitrichus*) from West Africa, presented by Miss M. A. Reeve; a Duke of Bedford's Deer (*Cervus xanthopygius*, ♀) from Manchuria, presented by H.G. the Duke of Bedford; a Suricate (*Suricata tetradactyla*) from South Africa, presented by Captain F. E. Cannot, A.S.C.; a Spur-winged Goose (*Plectropterus gambensis*) from West Africa, presented by H.E. Colonel F. Cardew, C.M.G.; a Common Heron (*Ardea cinerea*), two Mediterranean Peregrine Falcons (*Falco punicus*) from Mogador, presented by Mr. W. T. Barneby; a Kinkajou (*Cercoleptes caudivolvulus*) from South America, a Blue-bonnet Parrakeet (*Psephotus haematorhous*) from Australia, an Eupatorian Parrakeet (*Palaeornis eupatria*) from India, a Patagonian Conure (*Cyanolyseus patagonus*) from La Plata, three Caspian Terrapins (*Clemmys caspica*) from Western Asia, deposited; two Black-tailed Parrakeets (*Polytelis melanura*) from Australia, purchased.

OUR ASTRONOMICAL COLUMN.

New Variable in Cygnus.—Mr. A. Stanley Williams announces in the *Astronomische Nachrichten*, Bd. 154, No. 3675, the detection of a new variable star. Its position is

R.A. = 20h. 59m. 50s.
Decl. = +28° 49′·6 } (1855·0).

The magnitudes were obtained from measurements of photographs obtained with a Grubb 4·4 inch portrait lens, and were as follows:—

1899.	Oct. 6	...	Mag. = 9·85
	9	...	= 9·85
1900.	26	...	= 11·0
	Nov. 15	...	= 11·4
	22 (hazy)		= 11·4±.

In the same journal Prof. Kreutz gives a list bringing together all the new variables discovered during the past year.

Spanish Observations of the Eclipse of May 28.—A preliminary report of the observations of the total eclipse of the sun, May 28, made at Plasencia by the official party of Spanish astronomers, has just been issued by Señor Iniguez, director of the Madrid Observatory. The principal objects of the expedition were to record the times of the four contacts, to obtain photographs of the corona, and to determine the position of the green line of the coronal spectrum. The attendant phenomena, however, were not neglected. Among the larger instruments employed were an equatorial refractor of 20 centimetres aperture and 3 metres focus, a photographic equatorial of 20 centimetres aperture and 2 metres focus, a photographic telescope of 16 centimetres aperture and 1 metre focus, and a six prism visual spectroscope worked in conjunction with a coelostat and horizontal telescope. The weather conditions were excellent, and a very graphic account of the general work of the expedition and of the eclipse itself is given. Five excellent photographs of the corona were obtained, three with the larger and two with the smaller coronagraph. It is remarked that the principal prominences were unconnected with the coronal extensions, and that in one of the photographs the streamers can be traced to a distance of about three diameters. For the green coronal line a wave-length of 5297·3 was determined, as compared with Sir Norman Lockyer's 5303·7 and Prof. Campbell's 5303·26 obtained from the photographs of 1898. Shadow bands were seen a minute and a half before totality, lying in a direction from south-west to north-east and travelling from north-west to south-east with a velocity comparable with that of a man walking, and at a distance apart of 8 centimetres. The atmosphere was so clear that the moon's disc was seen projected on the background of the corona for two minutes after the last contact. During the eclipse the thermometer in the shade fell 4° and that in the sun 8°. An interesting series of photographs is reproduced to show the reduction of light at various phases of the eclipse, and copies of the corona pictures are also included in the report. Señor Iniguez, to whom many foreign astronomers were indebted for much valuable information relating to their expeditions, is to be warmly congratulated on the admirable results of the efforts of his own party.

Opposition of Eros.—A sixth circular has been issued by M. Loewy from the Paris Observatory, containing ephemerides of 81 fundamental stars selected from the region including the trajectory of Eros during the period 1900 September–December,

intended for use in the reduction of meridian measures of the planet. The positions for 77 of these are given at intervals of 10 days, and for the remaining four polar stars daily positions.

Two other observatories have undertaken the special task of determining the co-ordinates of stars for reference—Charkow, directed by M. L. Struve, and d'Abbadia, directed by M. l'Abbé Verschaffel.

Many notices have come to hand indicating that a considerable number of successful determinations have been made, and a scheme is being considered to ensure the publication of all the combined results in such form as to be of the greatest service to the observers, and thus any one may be able to have access to the complete data.

M. de Campos Rodrigues, director of the Lisbon Observatory, writes saying that 743 observations have been made; heliometric measures have been commenced at Bamberg, by M. Hartwig; at the Observatory at Algiers 63 photographs have been taken.

Both at Paris and Algiers it has been found that an exposure of six minutes is sufficient to record stars as faint as 12·5 magnitude, and from special trials it is considered that with this exposure it is certain that a sufficient number of comparison stars will be obtained surrounding the planet. Prof. Hale has forwarded the times of observation at which Prof. Barnard has taken micrometer measures with the 40-inch Yerkes telescope, and a comparison shows that several of these, made during the first part of the night, correspond almost directly with others obtained at European observatories (Paris and Cambridge) during the second part of the night.

A letter from Prof. Comstock is also included, giving particulars for the accurate determination of the diurnal motion.

MARKING ON MARS.—A Circular received from the *Centralstelle* at Kiel announces a message from Prof. Pickering, who on December 8 received a telegram from Mr. Douglass, of the Lowell Observatory, Flagstaff, Arizona, stating that he had observed a projection on the northern edge of the Icarium Mare which remained visible for seventy minutes.

SPECTROSCOPIC INVESTIGATIONS OF GASES IN ATMOSPHERIC AIR.[1]

IN August last some tubes were filled at low pressure by an improved process with the more volatile gases of the atmosphere.[2] The air was liquefied directly from that above the roof of the Royal Institution by contact at atmospheric pressure with the walls of a vessel cooled below −200° C. When about 200 c.c. of liquid had condensed, communication with the outer air was closed by a stop-cock. Subsequently communication was opened, through another stop-cock, with a second vessel cooled by immersion in liquid hydrogen, and a part of the liquid from the first vessel, maintained at −210°, was allowed to distil into the second still colder vessel. When about 10 c.c. had condensed in the solid form in the second vessel, communication with the first vessel was cut off, and a manometer showed a pressure of gas of about 10 to 15 mm. of mercury.

This mixture of gases was passed into tubes previously exhausted by a mercury pump, but before reaching the tubes it had to pass through a U-tube immersed in liquid hydrogen so as to condense less volatile gases, such as argon, nitrogen, oxygen or carbonic oxide, which might be carried along by those more volatile. Previous trials with tubes filled in the same way, except that the U-tube in liquid hydrogen was omitted, showed that these tubes contained traces of nitrogen, argon and compounds of carbon. The tubes filled with gas which had passed through the U-tube showed on sparking no spectrum of any of these last-mentioned gases, but showed the spectra of hydrogen, helium and neon brilliantly, as well as a great many less brilliant rays of unknown origin. In addition, they showed at first the brightest rays of mercury, derived no doubt from the mercury pump by which they had been exhausted before the admission of the gases from the liquefied air. After some sparking the mercury rays disappeared, probably in consequence of absorption of the mercury by the electrodes, which were of aluminium.

In one experiment the mixture of gases in the second vessel, into which a fraction of the liquefied air was distilled as above described, was pumped out without being passed through the U-tube in liquid hydrogen and examined. This mixture was found to contain 43 per cent. of hydrogen, 6 per cent. of oxygen, and 51 per cent. of other gases—nitrogen, argon, neon, helium, &c.—and it was explosive when mixed with more oxygen. This shows conclusively that hydrogen in sensible proportion exists in the earth's atmosphere, and if the earth cannot retain hydrogen or originate it then there must be a continued accession of hydrogen to the atmosphere (from interplanetary space), and we can hardly resist the conclusion that a similar transfer of other gases also must take place. The tubes containing the residue of atmospheric gases uncondensed at the temperature of liquid hydrogen we have examined spectroscopically.

On passing electric discharges through them, without any condenser in the circuit, they glow with a bright orange light, not only in the capillary part, but also at the poles, and at the negative pole in particular. The spectroscope shows that this light consists in the visible part of the spectrum chiefly of a succession of strong rays in the red, orange, and yellow, attributed to hydrogen, helium and neon. Besides these, a vast number of rays, generally less brilliant, are distributed through the whole length of the visible spectrum. They are obscured in the spectrum of the capillary part of the tube by the greater strength of the second spectrum of hydrogen, but are easily seen in the spectrum of the negative pole, which does not include the second spectrum of hydrogen, or only faint traces of it. Putting a Leyden jar in the circuit, while it more or less completely obliterates the second spectrum of hydrogen, also has a similar effect on the greater part of these other rays of, as yet, unknown origin. The violet and ultra-violet part of the spectrum seems to rival in strength that of the red and yellow rays, if we may judge of it by the intensity of its impressions on photographic plates. We were surprised to find how vivid these impressions are up to a wave length 314, notwithstanding the opacity of glass for rays in that part of the spectrum. The photographs were taken with a quartz calcite train, but the rays had to pass through the glass of the tube containing the gases.

We have made approximate measurements of the wave-lengths of all the rays which are sufficiently strong to be seen easily or photographed with an exposure of thirty minutes, and give a list of them below. These wave-lengths are computed to Rowland's scale, and were deduced from the deviations produced by two prisms of white flint glass for the visible, and of calcite for the invisible, rays. The wave-lengths assigned to the helium lines are those given by Runge and Paschen, and some of these lines were used as lines of reference. In general, the iron spark spectrum was the standard of reference.

The tubes when first examined showed the lines of the first spectrum of hydrogen vividly, and the earlier photographs of the spectrum of the negative pole contained not only the violet lines of hydrogen, but also the ultra-violet series as far up as λ 337. In order to get impressions of the faintest rays, exposures of half an hour or more were required, and a succession of photographs had to be taken so as to get different sections of the spectrum into the middle of the field, where measurement of the deviations would not be impeded by the double refraction of the calc spar. As the light of the negative pole only was required, the electric discharge was made continuously in one direction only, with the result that the hydrogen lines grew fainter in each successive photograph, and soon disappeared altogether. Along with the ultra-violet rays, the less refrangible rays of hydrogen also disappeared, so that no trace of the C or F line could be seen, nor yet of the second spectrum, so long as the current passed in the same direction as before. Reversal of the current soon made the F line show again, so that it seems that the whole of the hydrogen was driven by the current to the positive pole. The conditions under which this ultra-violet series shows itself are a matter of interest. It appears here in the midst of a brilliant spectrum due to gases other than hydrogen, and yet it is very difficult to obtain a photograph of it when no gas but hydrogen is known to be present, or, at least, to become luminous in the electric discharge.

We have had an opportunity of comparing the spectrum of the volatile residue of air with that of the more volatile part of gas from the Bath spring. The tube did not admit of the separate examination of the light from the negative pole, but

[1] "On the Spectrum of the more Volatile Gases of Atmospheric Air, which are not Condensed at the Temperature of Liquid Hydrogen." Preliminary notice by Prof. G. D. Liveing and Prof. Dewar.—Read before the Royal Society on December 13.

[2] In this paper we describe researches in continuation of those previously communicated to the Society by one of us, in a paper entitled "Application of Liquid Hydrogen to the Production of High Vacua, together with their spectroscopic Examination," *Roy. Soc. Proc.* vol. 64, p. 231.

was examined end on, so that the radiation probably included rays emitted from the neighbourhood of the negative pole. The whole of the hydrogen had been removed from the Bath gas, but not all the argon. In the spectrum of this gas the rays of helium are dominant, decidedly stronger than those of neon, although the latter are very bright. In the spectrum of the residue of atmospheric air the proportion of helium to neon seems reversed, for in this the yellow neon line is as much more brilliant than the yellow helium line as the latter is the more brilliant in the spectrum of Bath gas. All the prominent lines in the spectrum of the volatile residue of Bath gas were also in that of the residue of atmospheric air except the argon lines. There were, on the other hand, many lines in the latter not traceable in the former, some of them rather conspicuous, such as the ray at about λ 4664. It is, of course, probable that such rays are the outcome of some material not contained in the Bath gas. A very conspicuous pair of lines appears in photographs of the spectrum of the air residue, at about λ 3587, which is not traceable in the spectrum of Bath gas. The helium line, λ 3587·4, is seen in the latter spectrum, but is quite obscured in the former spectrum by the great intensity of the new pair. This helium ray is really a close double, with the less refrangible component much the weaker of the two, but the new pair are wider apart, and of nearly equal intensities; this character also distinguishes them from the strong argon line at λ 3588·6. They are, however, very much more intense at the negative pole than in the capillary, and it will require a good deal more study to determine whether these rays, and many others which we have not tabulated, are due to the peculiarity of the stimulus at the negative pole or to the presence of a previously unrecognised material.

As our mixture of gases probably includes some of all such gases as pervade interplanetary and interstellar space, we early looked in their spectra for the prominent nebular, coronal and auroral rays. Searching the spectrum about λ 5007 no indication of any ray of about that wave-length was visible in the spectrum of any one of the three tubes which had been filled as above described. Turning to the other green nebular line at about λ 4959 we found a weak rather diffuse line to which our first measure assigned a wave-length 4958. The correctness of this wave-length was subsequently verified by measuring with a micrometer eye-piece the distances of the line from the helium lines λ 4922·1 and λ 5015·7 which were in the field of view at the same time. The position of the line was almost identical with that of the iron spark line λ 4957·8, and the conclusion arrived at was that the wave-length was a little less than 4958, and that it could not be the nebular line. There remained the ultra-violet line λ 3727. Our photographs showed a rather strong line very close to the iron spark line λ 3727·8, but slightly more refrangible. As the line is a tolerably strong one it could be photographed with a grating spectrograph along with the iron lines. This was done, and the wave-length deduced from measuring the photograph was 3727·4. This is too large by an amount which considerably exceeds the probable errors of observation, and we are forced to conclude that the nebular material is either absent from our tubes, or does not show itself under the treatment to which it has been subjected.

Although the residual gases of the atmosphere, uncondensed at the temperature of liquid hydrogen, do not show the nebular lines, we found that another tube gave a ray very close indeed to the principal green nebular ray. This tube had been filled with gas prepared in the same way as the others, with the exception that, in passing from the vessel into which the first fraction of liquid air was distilled, it was not passed through a U-tube immersed in liquid hydrogen on its way to the exhausted tube. In consequence it contained traces of nitrogen and argon, and when sparked showed the spectra of these elements as well as those of hydrogen, helium, &c. The nitrogen spectrum disappeared after some sparking, but the tube still showed rays of argon as well as those of the gases in the other tubes. On examining the spectrum of the negative pole in the neighbourhood of the principal nebular green ray, a weak ray was seen in addition to those given by the other tubes. It was found by comparison with the nitrogen rays λ 5002·7 and λ 5005·7 to be a little less refrangible than the latter of these rays, and by measuring its distance from the nitrogen rays and from the two helium rays λ 4922·1 and λ 5015·7 with a micrometer eye-piece, the wave-length λ 5007·7 for the new ray was deduced. This looks as if we might find the substance which is luminous in nebulæ to be really present in the earth's atmosphere, and we hope shortly to be able to verify the observation of it.

Turning to the coronal rays, our tubes emit a weak ray at about λ 5304. This is not far from the wave-length λ 5303·7 assigned by Sir N. Lockyer to the green coronal ray. It is, however, greater than that assigned by Campbell, namely, 5303·26. Other lines observed by us near the places of coronal lines are at wave-lengths about 4687, 4570, 4358, 4323, 4232, 4220, 3985, 3800. These are all weak lines except that at λ 4232, which is of tolerable strength, and that at λ 4220, which is rather a strong line. The wave-lengths 4323, 4232, 4220 and 3800 come very close to those assigned to coronal rays, but the others hardly come within the limits of probable error. The ray 4220 seems too strong in proportion to the others, but the strength of that at 4232 seems to accord with the strength of the corresponding ray in the corona. It will be seen that the rays we enumerate above correspond approximately to the stronger rays in Sir N. Lockyer's list. Further measures of the wave-lengths of the faint lines are needed before we can say definitely whether or no we have in our tubes a substance producing the coronal rays, or some of them.

As to the auroral rays, we have not seen any ray in the spectrum of our tubes near λ 5571·5, the green auroral ray. We have observed two weak rays at λ 4206 and λ 4198, which may possibly, one or both, represent the auroral ray λ 420. The very strong ray of argon, λ 4200·8, would make it probable that argon was the origin of this auroral ray, if the other, equally strong, argon rays in the same region of the spectrum were not absent from the aurora. Nor have we found in the spectrum of our tubes any line with the wave-length 3915, which is that of another strong auroral line. On the other hand it seems probable that the strong auroral line λ 358 may be due to the material which gives us the very remarkable pair of lines at about the place of N of the solar spectrum, λ 3587, which are very strong in the spectrum of the negative pole, but only faint in that of the capillary part of our tubes. It may well be that the auroral discharge is analogous to that about the negative pole. We have also a fairly strong ray at λ 3700, which may be compared to the remaining strong ray observed in the aurora λ 3700. This, however, is a ray which is emitted from the capillary part of our tubes as well as from the negative pole, and is, moreover, emitted by Bath gas, and may very likely be a neon ray.

We hope to pursue the investigation of this interesting spectrum, and if possible to sort out the rays which may be ascribed to substances such as neon and those which are due to one or more other substances. The gas from Bath, even if primarily derived from the atmosphere—which is by no means sure—seems to have undergone some sifting which has affected the relative proportions of helium and neon, and a more thorough comparison of its spectrum with that of the residual atmospheric gases may probably lead to some disentanglement of the rays which originate from different materials. The arrangement of the rays in series, if that could be done, would be a step in the same direction.

The table appended to the above paper is not given here, but it consists chiefly of wave-lengths expressed in four figures only.

THE TREATMENT OF LONDON SEWAGE.[1]

WHEN, some years since, the raw sewage of London was regularly poured into the river in the neighbourhood of the city, the road detritus and putrescible fæcal matter which were delivered in the sewage settled on the river bed and foreshores. The road detritus tended to permanently reduce the depth of the river; while the putrescible matter, arriving faster than it could be removed by the river or could be destroyed by inoffensive bacterial action, accumulated as a deposit on the foreshores and floated in masses of thick scum on the river. It there underwent foul putrefactive changes, rendering the river most offensive to those who navigated it or lived and worked near its banks, and almost intolerable in summer weather, even to those who crossed its bridges. That this result was inevitable will be understood when it is remembered that the sewage consists of the whole of the water-supply and rainfall over the

[1] Abridged from a paper read before the Society of Arts, on December 12, by Prof. Frank Clowes.

metropolitan area which have been charged with varied refuse matters of our streets, our houses, and our manufactories.

The nuisance was removed by taking the sewage fifteen miles below London. Since this was found insufficient, the sewage was subsequently subjected to chemical treatment and sedimentation before it was allowed to flow into the river. The treatment ultimately adopted, and still in vogue, consists in straining or "screening" off the larger solid matters and then mixing the sewage with solutions of lime and sulphate of iron; the chemical precipitate thus produced is then allowed to settle, together with the finer particles in the sewage, by sending the sewage slowly through parallel channels on its way to the river. The settled matter, or "sludge," is sent in tank-steamers to be discharged out at sea beyond the river's mouth; and the fairly clear "effluent" passes constantly into the river from the northern outfall (Beckton or Barking) and the southern outfall (Crossness) in two streams, which jointly deliver over 200,000,000 gallons every twenty-four hours into the river, and which probably constitute the most important tributaries of the lower Thames near London. Since these processes of chemical treatment and sedimentation have been adopted, the foreshores of the river have become clean, the outrageous foulness of the stream has ceased, and those who live on and near the Thames unanimously express their approval of the improvement effected.

It must be remembered, however, that the effluent of the sewage, after it has been freed from visible foul matter, still contains in invisible solution a large amount of putrescible substance, which may, under suitable conditions, lead to serious foulness in the stream. The effluent at present discharged into the river is practically only clarified sewage. As long as putrefactive changes are delayed by low temperature of the river water, and an ample flush of upper river water comes down to dilute this effluent and to carry it rapidly out to sea, no sensible foulness occurs in the main stream. But in summer time, when high temperature hastens putrefactive change and diminishes the amount of oxygen dissolved in the river water, and when the flush of water from the upper river is diminished by drought and by the abstraction of larger volumes of the water by the water companies, the condition of portions of the lower river frequently closely approaches that necessary to cause offence. There can be no doubt that as the volume of sewage effluent increases, and the abstraction of upper river water for water-supply also increases with the increasing population, these portions of the lower river must pass more frequently into a condition bordering upon or actually causing foulness. It is, therefore, prudent to be prepared to adopt without delay a method of treatment of the London sewage which shall meet the requirements of an increasing population, and shall enable the more ample effluent to be discharged into the river in a state of greater purity than is at present secured.

As far back as 1893, the Main Drainage Committee of the County Council, on the advice of their chemist, Mr. Dibdin, started a large scale experiment on the bacterial purification of sewage, the purification being applied to the effluent from chemical treatment and sedimentation. This experimental treatment has been continued by the committee, on my own advice, and has been considerably extended in its scope. The committee also consented to the association of the eminent bacteriologist, Dr. Houston, with me in these experiments during the three years of their progress. The results which have been obtained have been published by the London County Council in the form of a series of reports which I have laid before them from time to time. The general conclusion to which they point is that the settled sewage may be purified to a far greater degree than it is by the present treatment, by encouraging the spontaneous purifying action of the bacteria which are present in the sewage itself. The effluent thus produced, without the intervention of chemicals, remains free from foul putrefaction and is able to support the life of fish; in these and in all other respects it is greatly superior to the effluent which is at present discharged into the river. The minute vegetable organisms, known as bacteria, exist to the average number of 300,000 per drop of sewage. They only require to be placed under suitable conditions in order to effect the rapid and inoffensive resolution of the putrescible matters of the sewage into harmless and inoffensive products.

The general conclusions derived from the experimental bacterial treatment of raw sewage at the out-falls of the London sewage into the Thames are as follows:—

(1) The following results were obtained by treating the raw sewage bacterially in coke-beds. In the process adopted, the sewage was allowed to flow into large tanks which contained fragments of coke about the size of walnuts. As soon as the level of the liquid had reached the upper surface of the coke-bed, its further inflow was stopped, and it was allowed to remain in contact with the bacteria coke surface for two or three hours. It was then allowed to flow slowly away from the bottom of the coke-bed. This out-flowing liquid constituted the "sewage effluent." After an interval of from three to seven hours, the processes of emptying and filling the coke-bed were repeated with a fresh portion of sewage. The coke-bed was at first filled in this way twice in every twenty-four hours, but later on it was filled three and four times in twenty-four hours.

(2) A considerable purifying action has been effected by the coke-bed. This is produced by the introduction of bacteria from the sewage. The maintenance of the purifying action is due to the presence of bacteria or their enzymes upon the coke surfaces, and to the adequate aëration of these surfaces by frequently exposing them to the oxygen of the air.

(3) The oxygen undergoes absorption by these surfaces, and the aëration of even the lowest portions of a deep coke-bed seems to be satisfactory in the above method of working, since the air present in the interstices of the coke, between two fillings with sewage, usually contains as much as 75 per cent. of the amount of oxygen present in the air.

(4) Raw sewage, which had been deprived of its larger particles by screening it through coarse gratings, lost practically the whole of its suspended matter by remaining in such a coke bacteria bed for two or three hours. It appears that the suspended particles of fæcal matter underwent liquefaction by the bacteria, since they did not collect upon the surface of the coke.

(5) The sand and grit and finer mud, arising mainly from the wear of road surfaces, however, were deposited upon the coke surfaces, and gradually reduced the capacity of the coke-bed.

(6) Hair, fibrous matter and woody fibre derived from the wear of wooden street pavements, and particles of chaff and straw mainly derived from the dejecta of horses employed in the street traffic, were also deposited upon the coke surfaces and gradually choked the coke-bed. These substances, which consist mainly of cellulose, are apparently only acted upon by bacteria with extreme slowness under the above conditions. They arrive, however, in a water-logged condition, and rapidly settle down from the sewage if its rate of flow is reduced.

(7) In dealing with the sewage of the metropolis, it seems best to submit the roughly screened raw sewage to a somewhat rapid process of sedimentation, in order to allow these suspended mineral and cellulose matters (5, 6) to subside; and then to pass the sewage direct into the coke-beds. The dissolved matters and the small amount of suspended matters which are still present in the sewage are then readily dealt with by the bacteria of the coke-bed, and no choking of the beds occurs.

(8) The sewage effluent which is thus obtained from the coke-beds is entirely free from offensive odour and remains inoffensive and odourless even after it has been kept for a month at summer heat, either in closed or open vessels. It is clear, except when a turbidity is produced by fine mud particles washed down by heavy rain. Many pond and river fish have been kept in the constantly renewed effluent for a month, and have been found to be perfectly healthy at the end of that period.

(9) The chemical character of this effluent may be briefly indicated by stating that on an average 51·3 per cent. of the dissolved matter of the original sewage, which is oxidisable by permanganate, has been removed by the bacteria, and that the portion which has been removed is evidently the matter which would become rapidly offensive and would rapidly lead to de-aëration of the river water if it were allowed to pass into the river. The above percentage removal (51·3) was effected by coke-beds varying from 4 to 6 feet in depth. A similar bed, 13 feet in depth, has proved more efficient, and has for some time produced a purification of 64 per cent., while an old bed, 6 feet in depth, has given a purification of 86 per cent. A repetition of the treatment of the effluent in a second similar coke-bed has produced an additional purification of 19·3 per cent., giving an average total purification of 70·6 per cent. (*See* Table I.). It should be noted that the above purification is reckoned on the dissolved impurity of the sewage; the suspended solid matter is not taken into account. No difficulty has been found in maintaining this bacterial purification.

TABLE I.—*Relative Impurity as Estimated by Permanganate.*

		Percentage purification calculated on clear raw sewage.
Raw sewage deprived of its suspended matter ...	3·696	
Effluent from chemical treatment	3·070	16·9
Effluent from single bacterial treatment	1·799	51·3
Effluent from double bacterial treatment	1·137	69·2
River water (high-tide) ...	0·550	—
,, ,, (low-tide) ...	0·429	—

(10) The bacteriological condition of the effluent corresponds in the main with that of the raw sewage. The total number of bacteria undergoes some reduction in the coke-beds, but the different kinds of bacteria which were present in the sewage are still represented in the effluent.

(11) The introduction of such a sewage effluent into the lower Thames is unobjectionable. The river water at the points where the effluent is discharged is uniformly muddy; it is always brackish and frequently salt to taste, owing to the presence of tidal sea water. It is, therefore, not capable of being used for drinking purposes. The effluent would certainly cause no deposit upon the river bed, and would ordinarily tend to render the muddy river water more clear by mixing with it. No offensive smell would be emitted by the effluent as it is discharged into the river. And, although the effluent contains more organic matter than the river water does, the bacteria which it contains would slowly and inoffensively remove this organic matter from the effluent after it has been introduced into the river. The effluent would be suitable for the maintenance of healthy fish-life.

A PRE-COLUMBIAN SCANDINAVIAN COLONY IN MASSACHUSETTS.

THE evidence in favour of a partial settlement of Massachusetts by Scandinavians is gradually accumulating, and in the current number of the *American Anthropologist* (New Series, vol. ii., p. 550), Mr. Gerard Fowke adduces new observations. He says, few persons living among the evidences of Norse occupancy have ever paid any particular attention to them, taking for granted that they are the work of the earlier generations of English inhabitants of the region. Those who give more than a passing thought to these objects of unknown origin can see at once that many features connected with them not only would have been unsuitable for any of the necessities of the latter people, as they were then compelled to live, but could not have been turned to any practical use when completed. Such a conclusion is followed at once by the inference that they must pertain in some way to the social customs in vogue among the American Indians; but it does not require an extended acquaintance with aboriginal remains to convince an observer of the error of this inference, the two classes of works being entirely different in many of their most distinctive characters.

Peculiar to the valley of the Charles river are the hut-sites excavated in the hillsides with their rows or piles of boulders to afford a resting place or foundation for the walls of the structures; the ditches that extend with practically a water level along the slopes of the hills; the dams that obstruct the river and many of its tributaries on both sides; the artificial islands walled or protected with stones; the stone walls along the margin of the streams, between high and low tide—none of these has a counterpart in any known works which can be attributed to Indian habits and life. Of very different character are the extensive earthworks in the bottom-lands; the hill-top fortifications of earth and stone; the immense tumuli of earth or stone, or both combined; and the huge flat-topped mounds of the Mississippi valley, erected by the Indian tribes popularly known as "mound-builders."

Remains of rectangular houses with very thick walls composed of stones and turf have been found of a size sufficient to accommodate several families in the old Scandinavian fashion. The long-houses of the Iroquois and some of the larger houses built by the Chippewa had the same general form, but with that the resemblance ceases. No foundation was necessary in the Indian house, and it was made principally or entirely of wood and bark. Similarly, nothing at all of Indian origin is known like the cot or hillside huts, of which a number have been examined. These are made by digging back into a sloping surface until a level floor of the desired area is formed; sometimes stones were placed around the sides, in one case (Fig 1) walls of stone and turf were built along the sides. There are indications that such places were covered with timber on which earth was piled.

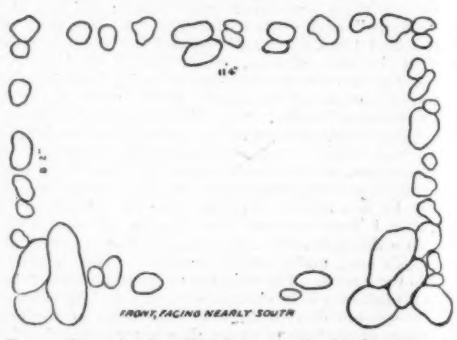


FIG. 1.—House-site above Sibley's, on opposite side of swamp, near Massachusetts Central Railway.

Near East Watertown is a large natural depression or "kettle-hole." Around two-thirds of the circumference of this, artificial terraces have been constructed, apparently to furnish seats from which spectators might view the exercises or ceremonies which presumably took place on the enclosed level area at the bottom. Somewhat more than a mile south of this "amphi-

FIG. 2 Supposed Norse grave at Clematis Brook, Charles River, Massachusetts.

theatre," at one side of a small area of smooth level bottom-land, a sloping bank rises rather steeply to a height of perhaps thirty feet; along this slope are three or four terraces, not large enough to be of any use for tillage. There is nothing in the eastern part of the United States known to be of Indian origin with which these may be properly compared.

The author describes the various kinds of burial works of the Indians, and compares the numerous cairns found in Massachusetts with Indian stone mounds, but most of these were very much larger than any cairns supposed to be constructed by the Norse. The Indian graves contain skeletons and relics. The stone cairns, the cairns in question, are called graves because they answer, in every particular of size and situation, to those mentioned in different sagas, and are in the midst of various other remains which must be attributed to the Northmen; and yet, in all that have been examined there has not been found the slightest trace of bone or any object which shows the least indication of being artificial. This, however, is only negative evidence; the same statement is true in regard to the graves of Iceland and Greenland; and not only of the graves in these countries, but also of the house-sites. It is also apparent that they differ from Indian graves even more in the manner of their interior construction than in their outward appearance. A. C. H.

PROGRESS OF SCIENCE TEACHING.

THE first report of the newly organised Board of Education has now been published. It consists of three volumes—the first contains the general report of the Board, the second is concerned only with secondary, and the third volume only with elementary education. A very important part of the second volume comprises the reports of the inspectors of the South Kensington branch of the Board of Education, who have charge of the teaching of science and art in different parts of the country. Without exception the inspectors tell a gratifying story of better equipment, improved methods, and saner ideals in the science schools visited by them. But though there has been a decided step forward there is still much to be accomplished and plenty of need for the best energies of both inspectors and teachers.

The reports are full of interesting details, it is true, yet certain broad questions touched upon by nearly every inspector are likely to be of greater general interest. The first of these the senior chief inspector, Mr. Gilbert Redgrave, refers to at some length. Readers of NATURE are already quite familiar with it—the unsatisfactory condition, that is, of the preliminary education of science and technical students in all parts of the country. Mr. Redgrave says: "I find that in a very large number of cases the work of the teacher in an evening class under this Board is crippled and rendered ineffective owing to the backward state of many of the students who enter the classes, and who are really only qualified for the evening continuation school." As Dr. Ball points out, in his report on the work of the South-Western district, the science inspector has no connection with public elementary education and consequently no means of officially acquainting himself with what provision is made for the teaching of science in the elementary school, and there can be little doubt that it is this want of continuity which is very largely to blame for the disparity between what an ex-standard scholar actually knows and what he should be acquainted with if he is to benefit by the instruction of the science class or technical school. Fortunately, local endeavour is doing something to remedy this evil. Mr. Hugh Gordon tells of an arrangement in the county of Durham by which, during the year with which his report is concerned, the County Council refused to grant aid on the attendance of students at a class in a subject unless the students could produce satisfactory evidence to show they possessed the necessary preparatory knowledge, or would attend concurrently such other classes as the teacher considered desirable. Similar instances could be cited, but this example will serve to exemplify what attempts are being made to cope with a real danger to our system of national technical education.

Another subject which very properly takes an important place in most of the reports is the need of practical instruction in all science teaching. There has, the reports show, been a decided improvement in the amount and character of the practical work in all branches of science, except, perhaps, in the case of physiography. In order to enable teachers to illustrate their lessons with properly prepared experimental demonstrations, and to foster individual practical work for their students, they must be given time in which to prepare such lessons. We are glad to see that Mr. Harold Wager calls prominent attention to this fact in his report on the Yorkshire division. He says: "The governors or managers of many of these schools have not yet fully appreciated the fact that teachers of practical science subjects require a considerable amount of time for the preparation of the experiments for their lessons beyond the time actually devoted to teaching. The necessary preparation for a good practical lesson in the laboratory is no light task, and if the work is to be done properly the teacher must have time for it."

Some progress in the direction of co-ordinating the work of the numerous local authorities for education has been made, but there still seems to be considerable misapprehension as to the precise limits of the sphere of influence of each committee or other governing body. It is gratifying to see that broad-minded counsels have prevailed in many centres, with the result that the very large amount of energy thereby saved has been devoted to the improvement of the local supply of scientific and technical instruction. Mr. Redgrave sketches a plan by which the different schools may work together in a satisfactory and harmonious manner. "The Technical School under the Town Council should be a day school for students who have passed through a course of two or three years in a School of Science, which might be conducted by the School Board, and who may desire to qualify themselves for good positions in industrial or commercial pursuits. The School of Science managed by the School Board would in each case be the preparatory school for the Technical School, but it would also provide an education complete in itself for those who leave school at the age of fifteen or sixteen. The evening classes at the Technical School should be classes in connection with the Board, or with the City and Guilds of London Institute, while the evening classes under the School Board should in all cases be those of the evening continuation school, and students should be encouraged to prepare for the classes under the Technical Instruction Committee by a course of study in the evening continuation school." Similar plans have, indeed, been already tried with great advantage in several centres, and it is much to be desired that some such sensible system of co-operation should be universally adopted.

Only part of the science teaching given in secondary schools comes within the purview of the reports under consideration, that, namely, which takes place in secondary schools receiving financial aid from the Board of Education. Mr. Buckmaster deals almost exclusively with this part of the work of the South Kensington branch of the Board. Among other matters which his report makes clear is the fact that there is likely to be some difficulty in the future in those cases where the inspector of the Board of Education and the organising secretary of a County Council Technical Instruction Committee come to different conclusions about a school after inspecting it. As Mr. Buckmaster says, "even in a county area cases may occur where the County Technical Committee will deprecate criticism on the schools it has selected as recipients of its grants."

The points of interest in this very valuable volume have been by no means exhausted by this brief notice. The chief topics only have been passed in review; the interested reader must be referred to the reports themselves for a more detailed account of a vitally important subject.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

DR. ARTHUR ROBINSON has been appointed professor of anatomy at King's College, London.

Science states that in an address to the students of Colorado College, Dr. D. K. Pearsons, of Chicago, announced that on January 1, 1901, he would make the college a gift of 10,000*l.* towards the cost of completing the new scientific building now in course of construction.

AT the close of his rectorial address at Aberdeen University on Tuesday, Lord Strathcona expressed his willingness to contribute 25,000*l.* to the University if within a year 50,000*l.* more were raised to complete the buildings and properly equip the University. Mr. Charles W. Mitchell has telegraphed to the Principal that he will be responsible for the whole of the present debt on the University buildings if it does not much exceed 20,000*l.* Mr. Mitchell is a son of the late Dr. Charles Mitchell, who was a liberal benefactor of the University.

A BASE measuring apparatus, which has been perfected in connection with the summer school work of the Civil Engineering Department of the Massachusetts Institute of Technology, has recently been tested by the Coast and Geodetic Survey in Washington. Such satisfactory results have been already obtained that the apparatus is about to be used in the important Lampasas Base in Texas. Prof. Burton, of the Institute, under whose direction the apparatus has been worked out, has been invited to accompany the expedition, which is to make a careful trial of the method in the field and upon extended exact work. The apparatus represents the final results of thesis investigations by several graduates of the course in civil engineering who have worked upon it in successive years. One part of the apparatus maintains a constant tension in the steel tape while in use. Another part of the apparatus determines very accurately the mean temperature of the tape by measuring its electrical resistance by means of a special form of thermophone devised by two graduates.

SOCIETIES AND ACADEMIES.

LONDON.

Physical Society, December 14.—Meeting held at the Royal College of Science (by invitation of Prof. Rücker), Principal O. J. Lodge, President, in the chair.—A paper on electric inertia and the inertia of electric convection was read by Prof. A. Schuster. Calculations of self-induction are based on the assumption that the currents which traverse a conductor fill it continuously, the flow being treated as that of an incompressible liquid. The assumption is generally recognised not to hold in the case of electrolytes where electricity is conveyed by a number of irregularly distributed ions. In the immediate neighbourhood of such an ion, the magnetic field is many times greater than that calculated on the supposition of continuous distribution, and hence the total magnetic energy is underestimated. What is universally recognised in the case of electrolytes must also be conceded when the current is conveyed by a gas, and the idea is gaining ground that even in solid conductors the current consists of positive and negative electrons moving with different velocities. It is the object of the paper to calculate the additional terms which become necessary for the evaluation of self-induction, and to discuss the possible cases in which the corrections may effect experimental results. The mathematical investigation shows that it is necessary to add a correcting term containing a quantity which may conveniently be called electric inertia. The author has calculated the numerical value of this quantity in the case of a solid conductor, and finds it to be about 2×10^{-13} C.G.S. units. It is of the dimensions of a surface. The experiments of Hertz have proved that if electric inertia exists, it must be less than 18×10^{-8}. In the case of liquids and gases, the electric inertia of the moving ions becomes much more important, and the calculation of self-induction by the ordinary processes gives erroneous results. The introduction of a term representing inertia alters the general equations of electric motion, and the author has applied his modified theory to Leyden jar discharges, the electrodeless discharges of J. J. Thomson, and the electromagnetic theory of light. In the case of electrodeless discharges in a vacuous globe, it is suggested that the absorption of energy may not only be due to the conductivity of the gas, but also to the inertia which it possesses.—A paper on magnetic precession was then read by the same author. The most delicate method of investigating the influence of electric inertia is based on the electromotive forces introduced by the motion of conductors carrying electric currents. If electricity behaves like a body possessing inertia, the rotation of a body through which currents pass should affect the flow of these currents in the same manner as the earth's rotation affects the direction of currents of air. If the earth's magnetism is due to electric currents, it is interesting to see if the effects of inertia can explain the secular variation. The investigation shows that a magnetic precession of the character of the secular variation would be produced, but that the precession would be very much slower than the variations actually observed. The subject is worked out mathematically, dealing first with the case of currents in a spherical shell, and then extending the result to the case of a solid sphere. The calculated period of a cycle comes out as 7×10^{14} years. If the currents are confined to a thin slice of the earth, the time would be reduced to about 14×10^{8} years. To produce the actual period of the secular change, the current sheet would have to be of molecular dimensions. This suggests the possibility of the phenomenon of secular variation being rather of a molecular than a molar character. Prof. Rücker congratulated the author upon his attempt to solve the problem of terrestrial magnetism, and expressed the hope that further calculation would throw more light upon this difficult subject. Mr. Blakesley asked if the time of the secular variation would be altered if the interior of the earth were liquid or solid. The chairman observed that the precession was rapid in the case of a thin layer of gas, and mentioned J. J. Thomson's notion that the electrons were thrown off by centrifugal force and formed a molecular layer. Hertz, in his experiments on electricity, had looked for material inertia besides electromagnetic inertia. In the present theory the distinction disappears, and there is only one inertia, and that electromagnetic. Prof. Ayrton said if the two forms of inertia were electromagnetic, he would like to know why, in detecting the second form, it was necessary to associate it with an absorption of energy, as in the case of an electrodeless discharge. In the case of ordinary self-induction there is no absorption of energy, and if there is absorption in the second form, and if they are both electromagnetic, he would like to know the difference between the two. Prof. Schuster, replying to Mr. Blakesley, said that if the interior of the earth were treated as liquid, the period of the cycle would be about one hundred times less. In reply to Prof. Ayrton, he said he had only cited one experiment to show that a phenomenon, explained by the gas being a good conductor, could also be explained by its electric inertia. It was impossible to say in general whether self-induction caused an absorption of energy or not.—Prof. A. W. Rücker read a paper on the magnetic field produced by electric tramways. Taking the case of a tramway in which the current flows along a trolley wire from the power-house, and returns partly through the rails and partly as earth currents, the author has shown that the vertical disturbing force at any point is due to the currents in the feeders and rails, and that the earth currents affect the horizontal force only. Experiment shows that it is chiefly the vertical force instruments which are affected by the establishment of an electric railway, and since this disturbance is due to the wires and rails it is impossible for an observatory to be protected by rivers or other natural features of the district. A preliminary investigation is based on the assumption that the trolley wires and rails are insulated conductors, and that a fraction of the whole current returns along the rails to the generator. The effect of the railway at a distant point is due to the difference of the current in the trolley wire and the hypothetical uniform rail current, the effect of which at the point considered is equivalent to the actual rail current, which varies from point to point. It is thus shown that the disturbance increases with the length of the tramway, and for a tramway of given length the disturbance is a maximum at points on a line perpendicular to and bisecting it. Experiments made at Stockton on the magnitude of the disturbing force gave, with the vertical force instrument, a leakage of 16·3 per cent., and with the horizontal force instrument a leakage of 15·9 per cent., a fairly close agreement. The assumption that the terminals of the line are above and below the average potential of the earth by the same amount respectively, and that the leakage at any point is proportional to the potential difference between the rail and the earth, leads to the ordinary theory of a Fourier bar. This more accurate assumption has been developed and applied to the results obtained at Stockton. The leakage, as calculated from the amperes and volts, comes out as 20 per cent. The calculation of the disturbing vertical force gives $10\cdot5\times10^{-5}$ C.G.S. units, which is in fair agreement with the value 7×10^{-5} actually observed. In conclusion, it is pointed out that for practical purposes it is sufficient to deal with the average return current through the rails, the formulæ for which are quite simple.—Dr. R. T. Glazebrook read some notes on the practical application of the theory of magnetic disturbances by earth currents. In this paper the author has thrown the extended formula obtained by Prof. Rücker in the previous paper into a workable form, and has tabulated numbers which show at what distances the disturbances are negligible for tramways of different lengths.—Prof. R. Threlfall exhibited a quartz-thread gravity balance. Prof. Threlfall gave a short description of this instrument, which has been described in full elsewhere. He drew attention particularly to its accuracy and portability. Mr. Simpson asked how far the fibre had been calibrated, and

if the instrument would be trustworthy at the freezing-point of mercury. Dr. Glazebrook asked how far the instrument was suitable for Antarctic expedition work. He drew attention to the difficulty of calibrating a new fibre should one get broken in the field. Mr. Appleyard suggested the use of a bath kept at constant temperature with a thermostat. Prof. S. P. Thompson suggested a special meeting to discuss the physics of the Antarctic expedition. Prof. Threlfall said that there was no difficulty in measuring the relation between temperature and coefficient of stiffness down to very low temperatures. A more difficult matter is the coefficient of temperature of the instrument. Shrinkage of the instrument as a whole affects both the fibre and the spring which supports it. The difficulty of a broken fibre in the field can be got over by taking two or three instruments. Working with a thermostat is useful in a laboratory, but decreases the portability in exploration work.—Mr. Watson then exhibited a set of half-seconds pendulums. In these pendulums special attention is paid to the stability of the support. The pendulums are covered by a hood, from which the air can be exhausted so that the logarithmic decrement is diminished. The motion of the pendulums is shown by rays of light reflected from right-angled prisms attached to them, and the period of oscillation is determined by the method of coincidences. For this purpose an accurate astronomical clock is used, and observations are made continuously between two time signals. An accuracy of one part in a million is attainable. In reply to Prof. Threlfall, Mr. Watson said that the knife-edges were on the pendulums, and not on the supports.—The Society then adjourned until January 25, 1901.

CAMBRIDGE.

Philosophical Society, October 29.—The President, Prof. A. Macalister, in the chair.—On the structure and classification of the cheilostomatous polyzoa, by Dr. Harmer. This communication dealt principally with the "compensation-sac," a name given by Jullien to a delicate vesicle lying beneath the front wall of the zooecia of many cheilostomes which have a rigid, calcareous body-wall. This cavity, described by Busk in 1884, and with more accuracy by Jullien four years later, has been looked for in vain or altogether ignored by the majority of recent observers. The compensation-sac is in reality an important organ in lepralioid polyzoa, and Jullien's account of its relations is confirmed.—Observations on the minute structure of the surface ice of glaciers, by Mr. Skinner. By pouring plaster of Paris on the ice surface a permanent cast can be obtained, from which it appears that the porosity of the white superficial layer of a glacier arises from two different causes. The first cause is the melting at the interfaces of the crystalline granules, and the second lies in the formation of small pits by the heat absorbed and radiated from small particles of dust. The two classes of holes are very distinct. Those of the first kind are straight furrows joined to form rough hexagons, and those of the second have a cylindrical or ellipsoidal shape. These pits may occur anywhere on the exposed surface of the crystal, and are like in shape to the larger pits formed by small stones and gravel on the glacier surface. Some other casts have been taken of the surface of the ice formed in ice caverns (glacières naturelles); these show only the melting at the interfaces and no pits. In the glacières the melting takes place very slowly and is due almost solely to the contact of air only slightly warmer than the melting-point.

November 12.—Prof. Macalister in the chair.—(1) The natives of the Maldives; (2) The atoll of Minikoi, by Mr. J. Stanley Gardiner. The Singhalese and Maldivians appear to be the result of dichotomous branching of a common stem, one division proceeding through the Laccadives to the Maldives, the other travelling to its present home along the west coast of Hindustan. Mr. J. Stanley Gardiner's second paper was taken as read. The atoll of Minikoi is situated on a bank extending down from the west coast of India to the south of the Maldives. The atoll has in the past evidently been raised to a height of at least twenty feet above the sea, before which it consisted of a mere ring-shaped reef awash. The land is now very rapidly being eroded on every side. The lagoon is broadening and deepening, and the reef is markedly growing outwards. The atoll probably grew up as a flat reef on some mound on the sea floor, subsequently attaining its present shape. The numerous deep bands of the Laccadives represent incipient stages in the formation of reefs on such mounds, while the islands and reefs exemplify the changes, which finally produce the perfect atoll.

November 26.—The President, Prof. Macalister, in the chair.—Some experiments on the electrical properties of a mixture of hydrogen and chlorine, when exposed to light, by Prof. J. J. Thomson. A series of experiments were made to see whether there is any production of free ions when a mixture of hydrogen and chlorine is exposed to light. If any such production took place it would cause the electric conductivity of the mixed gases to increase when exposed to light. This was tested by placing a small gold-leaf electroscope inside the mixed gas; the rate of escape of electricity was found not to be affected by exposure to light, either in the stage just after the incidence of the light when the mixture expands, or in the subsequent stages when the hydrogen and chlorine are combining. The problem was then attacked from a different side and free ions produced in the mixture by the aid of Röntgen rays or the radiation from thorium; though large numbers of ions were produced they had no appreciable effect on the rate of combination of the gases.—On the leakage of electricity through dust-free air, by Mr. C. T. R. Wilson.—Elster and Geitel have shown that an electrified body gradually loses its charge when freely exposed in the open air or in a room. Their results are in agreement with previous experiments of Linss. They conclude from their experiments that free ions exist in the atmosphere. The experiments described in this paper prove that ionisation can be detected in a small closed vessel containing dust-free air not exposed to any known ionising agents. To eliminate any uncertainty due to leakage through the insulating supports, the system from which the leakage was measured was fixed by means of a small bead of sulphur to a conducting rod passing through the wall of the vessel and kept at a constant potential equal to the initial potential of the leaking system. To reduce the capacity of the latter to the smallest possible amount, the whole system from which the leakage was measured was reduced to a small brass strip with a narrow gold-leaf attached, the deflections of which, read by means of a microscope, served to measure the potential. With a capacity of ·73 centim. there is a nearly constant fall of potential in a vessel containing 163 c.c. of air at atmospheric pressure, amounting to 3 volts per hour, the initial voltage being 220. The rate of leak is the same in filtered air whether the apparatus be filled and used in the laboratory (where contamination with radio-active substances might be formed) or in the country. The leakage takes place in the dark at the same rate as in diffuse daylight. The rate of leak is the same for positive as for negative charges. The quantity lost per second is the same when the initial potential is 120 volts as when it is 210 volts. Such voltages produce the "saturation" current and the rate of leak may therefore be used to measure the ionisation. The rate of leak is to a first approximation proportional to the pressure; at a pressure of 43 millims. the leakage is about one-fourteenth of that at atmospheric pressure. If we take the value found by Prof. J. J. Thomson for the charge carried by each ion, $6{\cdot}5 \times 10^{-10}$ E.U., we can take the experiments as indicating that 20 ions of either sign are produced per second in each c.c. of air at atmospheric pressure.—On a solar calorimeter used in Egypt at the total solar eclipse of 1882, by Mr. J. Y. Buchanan. By means of this instrument, which consists of a modified form of a Liebig's condenser mounted equatorially, the solar radiation collected is condensed 48-fold. Observations made with it show that, taking the radius of the earth's orbit to be 212 times the radius of the sun, the radiation of one sq. metre of the sun's surface is spread over 45,000 sq. metres of the earth's surface, whence the sun must radiate energy at the rate of at least 37,300 horse-power per sq. metre of its surface.—Some theorems in regard to matrices, by Mr. T. J. I'A. Bromwich.—On the rational space curve of the fourth order, by Mr. J. H. Grace.—On *Trifolium pratense*, var. *parviflorum*, by Mr. I. H. Burkill.—The writer has been able to examine plants of this so-called variety from Britain and various parts of the Continent, and to show that it is an abnormality in which the carpels are slightly foliaceous, the corolla crumpled, and with a few secondary modifications in other organs.

MANCHESTER.

Literary and Philosophical Society, December 11.—Prof. Osborne Reynolds, F.R.S., Vice-President, in the chair.—On the thermodynamical properties of superheated steam and the dryness of saturated steam, by J. H. Grindley. The paper contained a review of experiments with steam made by various observers. Some calculations were given which showed the

fallacy of accepting Regnault's linear law for the total heat and latent heats of evaporation of steam as a basis from which to determine the specific heats and other properties in superheated steam. Useful expressions for the products of the cooling effects and specific heat at constant pressure in steam were given, which would be of use for purposes of comparison with actual experiment. Two alternatives were offered in the paper for the true facts in saturated steam—either Regnault's results on the latent heats of steam can no longer be accepted, or the data deduced from experiments in the superheated condition must be rejected, as they cannot be made to agree.—On a new species of *Sepia* and on other shells collected by Dr. R. Koettlitz in Somaliland, by W. E. Hoyle and R. Standen. The new species of *Sepia* (*S. koettlitzi*) was collected at Zeila, nearly opposite Aden. It is most closely allied to *S. singalensis*, Goodrich, from which it differs in having the chitinous margin on the dorsal surface much narrower, and in the inner cone being flattened and (if anything) rather concave and not convex.

PARIS.

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THURSDAY, DECEMBER 27, 1900.

A CONTRIBUTION TO LAMARCKIAN EVOLUTION.

Sexual Dimorphism in the Animal Kingdom; a Theory of the Evolution of Secondary Sexual Characters. By J. T. Cunningham, M.A. Pp. xi + 317; with 32 illustrations. (London: Adam and Charles Black, 1900.)

HOWEVER much readers of this work may dissent from the views of the author, there can be no doubt that the volume is worthy of the most careful perusal. For the first time since the publication of Darwin's theory of sexual selection we have been provided with a bold and intelligible attempt at explaining secondary sexual characters on Lamarckian principles, and although many of us may arrive at the conclusion that Mr. Cunningham has not succeeded in establishing his case, it will be generally admitted that he has discussed the problem, on the whole, in a more or less scientific spirit, and has supported his arguments by a body of well-considered and, in many cases, original observations, which make his book exceptionally valuable as a storehouse of facts.

The author, as is well known, belongs to that school of anti-Darwinian evolutionists which accepts the broad doctrine of descent with modification, but which denies the sufficiency of natural selection as the cause of species formation. In the introduction he re-states some of the chief difficulties and objections which have been urged, over and over again, by the opponents of Darwinism. An analysis of these objections, as set forth by Mr. Cunningham, will show that they resolve themselves mainly into the inutility of incipient stages, the dictum of Romanes that natural selection is a theory of the origin of adaptations, the inutility of specific characters, the failure of natural selection to account for the origin of variation and so forth. Students of evolution are so familiar with these much-discussed topics that we may be excused from dealing with them again in detail. It is ancient history that Darwin admitted "use and disuse" and the "direct action of external conditions" as factors of some value in the production of species. But he assigned a subordinate function to these agencies, and it is quite unfair to Darwin's position to state, as Mr. Cunningham does (p. 12), that "if once we admit this, selection becomes a secondary and subordinate character."

What concerns us most here, however, is not so much the destructive part of the present work, because the author, in brilliant contrast to many critics belonging to his school, has not contented himself with mere cavil or with the watering-down process which is rife among certain sections of naturalists who regard with horror any attempt at dealing with the species problem by scientific method. Mr. Cunningham has formulated his own views, and has applied them to the particular, and, we may add, absorbingly interesting, class of phenomena presented by animals with dissimilar sexes. These views are, as the author will admit, purely Lamarckian—in fact we might say grossly mechanical, since the secondary sexual characters are regarded as the direct result of mechanical irritation or stimulation (p. 37). It is needless to point out that this view is absolutely at variance with that held by selectionists. It is a doctrine which has been broached of late years to account for floral structures, and which, if we are not mistaken, has received but little favour from botanists.

In defining Mr. Cunningham's position as a Lamarckian, it is necessary to point out, in order that full consideration may be given to his views, that he has introduced a certain modification into that doctrine which he claims—and we think rightly—to be original. Lamarckism, of course, carries with it the admission that acquired characters are hereditary, and the author's attitude towards this question will be considered subsequently. But whereas the original, or proto-Lamarckian, or his modern successor, the neo-Lamarckian, never appears to have troubled himself very much about the precise period in the life of the individual at which the "acquired" characters were produced, Mr. Cunningham has laid it down, as the essential part of his amendment, that these characters only become developed (by heredity) at "that period of life and in that class of individuals in which they were originally acquired" (p. 37). He further postulates that, in order to produce such hereditary acquired characters, the stimulations must "be regularly recurrent," and their transmitted effect is then only developed "in association with the physiological conditions under which they were originally produced" (p. 41). In other words, he re-states Darwin's "inheritance at corresponding periods of life" and "inheritance as limited by sex" from the Lamarckian platform, and imposes a new restriction in the way of "physiological conditions" which are nowhere defined throughout the work excepting in the case of secondary sexual characters, where the supposed conditions are vaguely associated with the change of constitution accompanying sexual maturity.

From these considerations it follows that the external stimulus or irritation which (admittedly) can modify a part or organ of an individual during its lifetime, is only capable of producing modifications of specific rank when applied continuously, throughout many generations, at some particular, and at present undetermined, state of physiological activity. Supposing we admit, for the moment, that the author's position is sound for the only case in which such special physiological conditions are hinted at, viz., the period of puberty, then it follows that those mutilations which have been carried out through successive generations in many tribes of savages at the precisely critical period required by the hypothesis might, at any rate, be expected to show now and again a tendency to appear spontaneously in the offspring at that period. The evidence on this point is certainly against the author, and the case for Lamarckism in its amended form receives no more support by virtue of Mr. Cunningham's amendment than did the original Lamarckism from the consideration of such classes of facts. It is, perhaps, not going too far to say that the author's position is less tenable by virtue of his own restriction than that of the older Lamarckians, because the whole explanation of sexual dimorphism, from Mr. Cunningham's standpoint, is made to depend upon the action of external stimuli applied at the period of breeding, *i.e.* at sexual maturity.

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